INSECT ENEMIES

by

C. A. EALAND

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INSECTS AND MAN

AN ACCOUNT OF THE MORE IMPORTANT HARMFUL AND BENEFICIAL INSECTS, THEIR HABITS AND LIFE-HISTORIES, BEING AN INTRODUCTION TO ECONOMIC ENTOMOLOGY FOR STUDENTS AND GENERAL READERS

BY

C. A. EALAND, M.A.

LATE PRINCIPAL OF THE EAST ANGLIAN COLLEGE OF AGRICULTURE

Illustrated with One Hundred Drawings and Sixteen Reproductions from Photographs

"Mr Ealand's book should be forced on the attention of the farmers who allow their stockyards, their piggeries, their accumulations of manure to poison (by means of the flea, the housefly, the cockroach, bug, and tick agencies) all who live sufficiently near to their holdings to have their food or their persons infected by the germs generated in excreta. Copies of the book should be furnished to every elementary, primary, and secondary school throughout the kingdom. . . . It should be in the hands of every man or woman who is selected for employment in the British tropical Colonies or Protectorates. Every official serving the Foreign, the India, and the Colonial Offices should be examined in its contents to ascertain if he properly appreciates the part played by insects in the affairs of Man. Our Boards of Guardians, our District and County Councils, should similarly take to heart the lessons deduced from the study of insects. They should be brought to realise that at least two-thirds of human diseases are preventable if you can destroy the transmitting agency of the germ that provokes the disease."

Sir HARRY JOHNSTON in the *Nineteenth Century.*

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ENUMERATING THE LIFE-HISTORIES AND DESTRUCTIVE HABITS OF A NUMBER OF IMPORTANT BRITISH INJURIOUS INSECTS. TOGETHER WITH DESCRIPTIONS ENABLING THEM TO BE RECOGNISED, AND METHODS BY MEANS OF WHICH THEY MAY BE HELD IN CHECK

BY

C. A. EALAND, M.A.

AUTHOR OF "INSECTS AND MAN"

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PREFACE

THE gratifying reception accorded to *Insects and Man* by the public and, with one exception, by the Press, is responsible for the appearance of the following pages. *Insect Enemies* is devoted solely to British injurious insects. The unrelenting, never-ceasing warfare which the majority of insects wage against mankind or his property is, for the moment, overshadowed by the tragedy being enacted on the battlefield of Europe. Sooner or later the curtain will be rung down on the final act, and then, if agriculture is ever destined to take its proper place as a national industry, considerable attention must perforce be paid to the insect problem. Not alone the husbandman, but the householder and all who have the national welfare at heart, should give more than passing thought to their six-legged enemies. A knowledge of the habits and life-histories of these creatures is essential if their activities are to be checked, and it is hoped that the pages of *Insect Enemies* may be of some assistance towards the identification and eradication of some of the more frequently encountered noxious insects. My thanks

are due to all those who have helped in the production of *Insect Enemies*, and especially to the Secretary of the Board of Agriculture and Fisheries for the loan of the blocks used in Figs. 7, 10, 21, and 28; to Mr H. Knight for his carefully executed original drawings, which lend an added interest to the book; and to my publishers for meeting my wishes in every way.

C. A. E.

LONDON, 1916.

CONTENTS

LIST OF DRAWINGS

INSECT ENEMIES

CHAPTER I

INTRODUCTION

In a previous volume, *Insects and Man*, we made an attempt to present a summary of the more important and interesting ways in which the human race is influenced, for good or ill, by a multitudinous host of insect enemies and allies. That not all the insect activities, that not even a tithe of them, could be included in a single volume is self-evident to anyone who has dipped ever so slightly into the domain of economic entomology.

According to the celebrated entomologist Lintner, "Insects have established a kind of universal empire over the earth and its inhabitants. Minute as many of them are, and insignificant in size to other than naturalists, yet, in combination, they have desolated countries and brought famine and pestilence in their train. If unrestrained power could be given them, all counterchecks removed, and they were left to attack us in our person, food, clothing, houses, and domestic animals, the consequent disease, poverty, and want would in the end remove the human race from the face of the earth. Air, earth, and water teem with them; there may be claimed for them almost an omnipresence. They swarm in the tropics and find a suitable home in the Arctic regions. They abound in

our homes, our gardens, orchards, fields, vineyards, and forests. In the vegetable kingdom they are found in the seed, the root, the stalk or trunk, the pith, the bark, the twig, the bud, the leaf, the blossom, the fruit, within or upon every portion of the vegetable organism. They are parasites on our person and upon or within all of our domesticated animals.

"They attack and destroy fishes and birds. They have their natural home in many of our articles of food. No asylum is so secure that they may not intrude: no condition in life is exempt from their presence."

Events succeed one another with cinematic rapidity in this newest of the sciences. To-day's triumph of patient research is the commonplace of to-morrow. The harmless insect of yesterday may, at any moment, stand convicted of some foul deed, as a disease-carrier or a destroyer of crops; or—and this is less likely —some useful service may be put to the account of a creature which has previously been considered wholly bad.

We, in Britain, are notoriously slow to move when we are confronted with new problems and unaccustomed difficulties, but we are credited with holding on, with considerable tenacity, when once we get to grips with realities. That we have been slow to take action in our dealings with the insect world is only too true. We can, however, hardly designate this subject new or unaccustomed, for, long years before the Christian era, man intuitively looked upon insects, in the main, as being inimical

to his well-being. Whether we shall eventually rise to the occasion and, recognising the enormous toll that is levied by injurious insects on mankind himself, his stock and crops, take concerted action for their destruction, or whether, ostrich-like, we shall hide our heads and allow the winged armageddon to overwhelm us, the future alone can tell.

That we are suffering now for our remissness in the past was succinctly observed by Sir Harry H. Johnston in the *Nineteenth Century* some few months ago, when he wrote: "It may be that our present sufferings due to arthropod malignity are a punishment for Man's own devastations—a hint of the blindly brutal, speechless kind — which is part of the rough instruction Man has received from some higher power during the long martyrdom of his apprenticeship in the art of governing a planet. Man himself — especially and before all, Man of the highest developed, Nordic type—has wantonly destroyed his beautiful and faithful allies the birds, has stupidly put out of existence many and many a harmless and useful reptile that only lived to devour insects and ticks. He is now paying the penalty in the present alarming spread of germ-diseases, in the diminution of his animal and vegetable food supply, which are due to the activities of the insect world and of the minute organisms that they may carry in their intestines or their gullets, or on their hairy legs or bristly backs, and introduce into the skin, the stomach, or the veins of Man, beasts, and birds, or into the tissues of plants."

Gilbert White said, nearly a century and a half ago, that "the most insignificant insects and reptiles are of much more consequence and have much more influence in the economy of nature than the incurious are aware of." Nevertheless, the fact remains that comparatively little is known about our commonest and our most noxious insects. The house-fly is a case in point: till Dr C. G. Hewitt began his valuable researches in 1905, nothing of any consequence had been published concerning this pest since 1790. This being the case with an insect that has followed man wherever he has gone, from the Arctic regions to the tropics, it is easy to imagine the state of affairs with regard to less-known and less widely distributed species.

Investigators are busy everywhere, grappling with the vast array of problems presented by the insect world in its relation to mankind, and great advances in our knowledge have been and are being made. In this respect the outlook is of the brightest, but what of the man to whom an insect is at worst a harmless nuisance? Is he also learning that insects may carry fell disease? Of little avail for the scientist to discover that the house-fly problem can be efficiently solved by rational methods of refuse destruction, if the housewife leaves her dustbin uncovered or the horsekeeper his manure-heap untended, as a congenial breeding-place for these two-winged pests.

It is the fashion in this country to decry popular and semi-popular writing on science; a number of superior persons would banish all such works from

the book mart. This is undoubtedly one of the reasons why the man in the street considers biology as beyond the pale. In the millennium when lamplighters learn from Lamarck, sempstresses study Spencer, and dockers dote on Darwin, the day of the popular book will indeed have waned, but that is not yet. Unless and until those who have no scientific training are told of the activities of insects, in language which they can understand, they can hardly be expected to be other than phlegmatic concerning the work of entomologists. The best methods of dealing with these enemies of mankind may be revealed by the comparatively few economic entomologists, but the great work of eradication can, in many cases, only be accomplished by the active co-operation of the general population.

In the following pages we will endeavour to study some of the activities of British insects: the majority of our present subjects were not mentioned in the pages of *Insects and Man*, where we attempted to deal with world-problems, rather than with those nearer home. We would emphasise the fact that our pages are intended as an introduction to the field of economic entomology. Some critics who ought to know better, and some of the non-critical, probably because they don't know any better, clamour for the whole subject in a nutshell. No one has yet said, or can ever hope to say, all that there is to be said in this wide and ever-widening subject.

Our aim is to create interest in economic entomology; once that interest is aroused, the intelligent

reader will find ways and means of probing the subject more deeply. Nothing has gratified us more than the number of letters we have received from readers of *Insects and Man*, asking for advice concerning the more detailed study of entomology. It is gratifying to have caused even an infinitesimal number of people to realise that a stern and never-ending struggle is taking place between the highest and nearly the lowest members of the animal kingdom.

In Britain, the destruction wrought by insects is not forced upon our notice so persistently as in the tropics, where man's six-legged enemies literally swarm, where many insect-borne diseases, unknown to colder climes, are rife. It is also safe to say that in America, and even on the Continent, the injurious insect is a greater power for evil than in this country.

Hewitt states that, at a conservative estimate, insect pests do damage to the extent of £20,000,000 annually in Canada, much of which could be prevented. According to Noel also, three hundred and fifty varieties of plants are cultivated in France and produce £360,000,000 sterling annually. These plants are attacked by about six thousand species of insects and two thousand fungoid diseases, which cause a loss of £120,000,000. Deriving what comfort we may from these assertions, the fact remains that, were some enterprising statistician to collect data concerning the losses to British farmers and gardeners, caused directly or indirectly by insects, together with statistics of the illness and mortality attributable to the same agency, his figures would be as startling as they were interest-

ing. Such work, however, can only be carried on approximately in our present state of knowledge, for, although recent years have taught us a great deal, it is too much to hope that we have as yet taken the finger-prints of every insect criminal, to use a very mixed metaphor.

As in our previous volume, we have not limited our pages strictly to the consideration of insects. We have a little to say concerning ticks and mites, which are not insects at all; nevertheless, they may be conveniently studied along with their near relatives.

Before we are in a position to study insects, it is necessary to be clear what insects are. We cannot recognise them by general external form, for some of them resemble sticks, some pieces of chaff, and some again closely imitate leaves and flowers. We certainly cannot distinguish them by size, for, whereas some are roughly a foot in length, others are so minute that we must examine them under a hand lens to be able to recognise them at all; certain beetles of the family *Trichopterygidæ* are only one-hundredth of an inch in length.

The only description that applies to every adult insect is, that it has six legs and a distinct head, thorax, and abdomen. The fact of a creature being six-legged is not, in itself, sufficient to show that it is an insect, for young mites and ticks are six-legged, but they are not insects, because they have no separate abdomen and thorax. Woodlice, millipedes, spiders, mites, ticks, and insects, with which our pages are concerned, all belong to the division of the animal

kingdom known as Invertebrates, or Achordata, that is to say, they are devoid of a spinal column. Moreover, they are all placed in the same group or phylum, the Arthropoda, which is split up into four classes: (1) Crustacea (woodlice, etc.); (2) Myriapoda (millipedes, etc.); (3) Arachnoidea (spiders, ticks, etc.); (4) Hexapoda (insects). The Arachnoidea are subdivided into (*a*) Araneida (spiders) and (*b*) Acarina (mites and ticks). Each of these classes is made up of orders, each order of families, each family of genera, each genus of one or more species, which may be further subdivided into sub-species and varieties. The term classification is used to denote this arrangement of animals or plants in their various classes, orders, families, genera, and species; unfortunately, various systems of classification have been introduced from time to time, so that a certain amount of confusion has arisen.

For our present purpose we will consider the insects as belonging to ten orders—some authorities divide them into less, others again recognise a score or more:—

Order I.—Aptera (No wings). Small insects without wings or rudiments of the same. Relatively soft-skinned, and possessed of well-developed antennæ.

Order II.—Orthoptera (Straight wings), including locusts, grasshoppers, crickets, earwigs, and cockroaches. Insects having, for the most part, leathery fore wings and membranous hind wings. Some have only rudiments of

wings or none at all. Larvæ and adults have biting mouth parts. Metamorphosis is incomplete.

Order III.—Neuroptera (Nerve wings), including dragon-flies, lace-wings, caddis-flies. Insects with two pairs of much-veined wings of about equal size. Larvæ and adults have biting mouth parts. Metamorphosis is incomplete.

Order IV.—Hymenoptera (Membrane wings), including bees, wasps, hornets, and ants. Insects with two pairs of membranous wings, of which the hinder are the smaller. Mouth parts adapted for biting. Metamorphosis complete.

Order V.—Coleoptera (Sheath wings), beetles. Insects with two pairs of wings; the fore pair (elytra) are hard and form a cover for the hind membranous pair. Mouth parts adapted for biting. Metamorphosis complete.

Order VI.—Lepidoptera (Scale wings), including the butterflies, with clubbed antennæ, and the moths, with filamentous or feathered antennæ. Insects with four membranous wings covered with scales. Mouth parts of larvæ adapted for biting, of imagos for sucking. Metamorphosis complete.

Order VII.—Diptera (Two wings), flies and gnats. Insects with a pair of membranous wings and a pair of rudimentary club-shaped organs called halteres or balancers. Mouth parts adapted for sucking or quite rudimentary. Metamorphosis complete.

Order VIII.—Siphonaptera (Wingless sucking insects), fleas. Insects with laterally compressed bodies and very small eyes (sometimes absent). Short, thick antennæ which fit into depressions above and slightly behind the eyes. Complete metamorphosis.

Order IX.—Thysanoptera (Tassel wings). Small, usually four-winged insects. The wings are fringed with hairs on one or both margins; sometimes the wings are rudimentary or absent. The young closely resemble the adults, but they pass through a resting pupal stage.

Order X.—Rhynchota (Beaked insects), bugs. Insects with mouth parts modified into a rostrum or beak, resembling a jointed rod in appearance. As a rule there are four wings. The base of the fore wings is often horny, with a membranous apex. Sometimes, again, the apical and basal portions are of the same consistency. Metamorphosis is incomplete.

Every insect that has been described by scientists bears a name, indicating its genus and species. Thus, the common house-fly is known to science as *Musca domestica,* Linn., just as someone of our acquaintance may be called Smith, John; in other words, the common house-fly belongs to the genus *Musca* and the species *domestica.* Linn. is an abbreviation of Linnæus, the name of the Swedish naturalist who first described the insect. All this may sound pedantic, and is probably looked upon as an excuse to introduce some of the fearsome words to which scientists are sup-

posed to be addicted. Everyone will agree that it is necessary to give some name to each insect; the choice lies between a popular name and a scientific one. The great objection to popular names is that the same insect may have a different name in different countries; the names may even differ in different counties. Thus the fly *Muscina stabulans* has often been called the stable-fly, which is more correctly the popular name of another fly, *Stomoxys calcitrans*. Popular names, again, are often clumsy and far more difficult to memorise than scientific names. A scientific name will convey a definite idea to entomologists the world over, no matter what their nationality. Popular names, too, are often misleading. The blackbeetle is not a beetle, the may-fly is not a fly, nor is the green-fly; and a slight acquaintance with entomology will reveal the fact that these misnomers are all too common. Our remarks may have conveyed the impression that each insect has one scientific name and one only; unfortunately this is not always so. A scientist may discover a new insect and describe it, giving it, at the same time, a name by which it will be known to the scientific world. Maybe only a single specimen is known. Later, someone else may capture an exactly similar insect, and, not knowing that it has already been described, may proceed to give it a name. How then do entomologists proceed in such an event? The name first given to the insect is the one by which it is to be known, and the later name is a synonym of the first.

In some cases the males and females differ to such an extent that, having been found separately, without any clue to their relationship, they have been given different names. Again, different authors have at times given the same names to different insects. For instance, in 1790, an entomologist named Olivier named a wood-boring beetle of the family *Bostrychidæ, Sinoxylon muricatum.* Nearly a hundred years later, an Italian scientist, Targioni Tozzetti, gave the same name to another beetle of the same family; that is why it is essential to give the author's name in addition to the name of the insect. An entomologist would know that the *Sinoxylon muricatum* of Olivier was not the same as the *Sinoxylon muricatum* of Targioni Tozzetti.

Interesting and, to the economic entomologist, important phenomena are the changes that take place during the life-cycles of insects, collectively known as metamorphoses. Interesting, on account of the apparently sudden and startling change from the inert chrysalis to the active perfect insect; from the minute egg to the voracious larva. Important, because an insect that is harmless in one stage may be decidedly harmful in another. Metamorphosis may be complete or incomplete. In a few orders there is no metamorphosis; from the egg there arises a miniature insect, which after a number of moults becomes adult. In the case of incomplete metamorphosis, a larva arises from the egg, but instead of being totally dissimilar to the adult, as we might expect, it strongly resembles its parents. By a

succession of moults the resemblance becomes closer till it reaches the nymphal stage, from which it develops into an imago or perfect insect. Incomplete metamorphosis is the rule with the cockroaches, earwigs, and grasshoppers. When metamorphosis is complete, from the egg emerges the caterpillar or maggot, known as the larva, totally unlike the adult. We next find a resting stage or, to be more correct, it is apparently so, but in reality great though unseen changes are taking place; this is the period of the chrysalis or pupa. Finally, the pupa gives rise to the perfect insect or imago. The house-fly, the cabbage butterfly, and the lady-bird all undergo complete metamorphosis. Lastly, complete metamorphosis may be somewhat modified from various causes, such as the production of larvæ by the mother insect instead of eggs, as in the case of the sheep bot-fly and tsetse flies; or, again, the larval stage may be complicated by a hyper-metamorphosis which is fully described elsewhere (p. 192), so need not be considered here.

In certain of the gall midge flies (*Cecidomyiidæ*) pædogenesis takes place; that is to say, certain of the larvæ produce other larvæ, instead of passing into the pupal stage. These extraordinary larva-producing larvæ emerge from large eggs laid by the female fly. Eventually young larvæ escape from the body of the parent larva, by boring through the skin. Several of these pædogenetic generations may arise before the larvæ pass to the pupal stage.

The economic entomologist should make a point of becoming acquainted with the life-histories of all the

insects he encounters. By doing so, he will gain information which will be of the greatest use to him in his efforts to combat his foes. He will learn, if he studies the question intelligently, that there is probably some particularly vulnerable period in each life-cycle. Having found this weak spot, no time should be lost in attacking the insect.

A study of the feeding habits of injurious insects is also important, and will quickly reveal the fact that in some cases harm is only done at one period of the life-cycle; moths, for example, are only harmful in the larval stage. In other cases the larval and adult stages may be harmful; this is observed in certain beetles. For the most part insects damage plants in one of two ways, by biting them or by sucking their juices; there are some important indirect methods of insect damage, but, in the main, damage is done by biting or sucking. Two examples will make the statement clear. Observe any caterpillar in the act of feeding—a pocket lens will make the observation clearer;—it usually begins at the edge of a leaf; its jaws may be seen working, and the leaf passes, piece by piece, into its mouth. A green-fly may serve as our next example, and in this case a pocket lens is a necessity. Looking sideways at the insect in the act of feeding—any untended rose tree will provide the object—it will be observed that it is armed with a beak, which it digs deeply into the plant tissues. This beak or rostrum serves a double purpose; it anchors the green-fly, and through it plant juices are sucked up. The green-fly, then, is a

sucking insect. A knowledge of the feeding habits of harmful insects is important, for on that knowledge our remedial measures are based: biting insects are combated by poisoning their food; methods have been devised for dealing direct with sucking insects.

A study of physiology may also be put to good account in dealing with insect pests; in fact, one physiological phenomenon has already proved of considerable utility. Everyone knows that certain moths are attracted by light; they exhibit phototropism. This trait has been utilised, with considerable effect, for more than a hundred years in dealing with vine moths on the Continent. Experiments have shown that diffused rays are more attractive than direct ones, and dull light than bright. There is still some doubt as to whether white or green light is the more attractive.

In the following pages we will consider the life-histories of some of our more important British economic insects, their activities, and methods of combating them. With regard to remedies, we would warn our readers that finality has by no means been attained. New methods are continually being revealed or old ones improved, and the man who has sufficient confidence in himself to announce that he has said the last word, as some unfortunately do, is more to be pitied for his want of perception than admired for his pluck.

CHAPTER II

FORESTRY PESTS

THE hypercritical may remark that we possess no forests of importance, therefore it is fatuous to consider the insect enemies which are likely to attack trees destined to produce timber. Compared with those of America, Canada, Australia, and even Europe, our forests are certainly insignificant, but that is at least an argument for their good preservation. It is surely wise to make the best of the little we possess. That there is plenty of scope for the enthusiastic entomologist who devotes his studies to forest pests, may be gathered from the fact that one tree alone, the oak, is subject to attack by no less than fifty species of insects. Scots pine and willow can also show, respectively, more than a score of pests, whilst others of our commoner trees do not lag far behind in this respect.

LEPIDOPTERA

A large number of Lepidoptera must, perforce, be included amongst the enemies of forest trees, and, of them, the members of the family *Tortricidæ* are, perhaps, the most notorious. All the adults of this family are relatively small and the larvæ, for the

most part, are given to a habit of leaf-rolling. The worst offenders, belonging to the genera *Retinia* and *Tortrix*, deserve some attention. Of the former, *Retinia buoliana*, Schiff., is quite a common pest of Scots and Austrian pines. The Pine-shoot moth, for that is the popular name of the insect, measures about three-quarters of an inch, or rather more, from tip to tip of its expanded wings. The hind wings are brownish grey; the fore wings are orange, marked with irregular transverse silver-coloured bands. The abdomen matches the hind wings in colour; whilst the head and thorax are yellow, with the exception of the eyes, which are black.

The life-history of the Pine-shoot moth is peculiar and interesting. Towards the end of July, the female moth deposits her eggs almost at the extreme tip of a shoot of the food plant. Owing to the fact that the year is well advanced before oviposition takes place, one may surmise, and surmise correctly, that the winter is passed in the larval stage. It is late summer before the larvæ appear, and they at once begin to eat a pine bud. Their efforts are not, at this season, directed to obtaining food but to making a wound in the food plant. Everyone knows that conifers are rich in resin. The caterpillars evidently know this too, and from the wounds they make resin flows freely, forming hollow resinous galls, shelters in which they hibernate. In the spring, the larvæ issue from their winter quarters and proceed to attack the leading bud of their food plant. As the result of their attacks, the shoots which have

suffered from their attentions either die or are badly deformed. The larvæ which cause this havoc are very small, dark chocolate in colour, with black legs and heads. About midsummer, or shortly afterwards, pupation takes place within the damaged shoots, and, from the chestnut-brown pupæ, the moths emerge towards the end of July.

The Pine-bud moth, *Retinia turionana*, Hb., has very similar habits; it is not, however, quite so common as its near relative. The adults are on the wing earlier in the season than are those of the Pine-shoot moth. They are smaller than the latter, with very pale grey hind wings and brown-grey fore wings; the abdomen is grey, the head and thorax red-brown. The larvæ are very much lighter coloured than those of *R. buoliana*.

A third species, *R. resinella*, L., is less injurious and need not be considered in detail. After the manner of the Pine-shoot moth larvæ, the caterpillars of *resinella* construct resin galls in which to hibernate. During the winter, each larva is ensconced in a gall about the size of a boot button; in early spring, the gall increases to four times its original size and is double-chambered (fig. 1). One chamber is occupied by the larva and, later, by the pupa; the other is filled with frass.

Remedies are of little avail against these pests. The injured shoots may be gathered and burned at the time they contain larvæ or pupæ. Light-traps are of some value in catching the moths soon after they have emerged and before they begin to oviposit.

FIG. 1. RESIN GALL OF *Retinia resinella*, L

FIG. 2. GOAT MOTH, *Cossus ligniperda*, F

The Green Tortrix or Oak-leaf Roller moth, *Tortrix viridana*, L., another of the *Tortricidæ*, is a serious pest of oak, the larvæ often completely defoliating the trees in late spring or early summer. It is sometimes erroneously stated that oak is the only tree attacked by this insect; it has been recorded, however, from ash, hazel, lime, beech, maple, horse-chestnut, and mountain ash. The adult is a striking and easily distinguished insect, measuring nearly an inch from tip to tip of its expanded wings. Its head, thorax, and abdomen are very pale yellow, its hind wings pale grey, and its fore wings green.

About midsummer the moths appear and eggs are deposited, singly or in groups, on the trees which will serve as food for the larvæ, probably near the buds, though this is a debated point. Winter is passed in the egg stage, the larvæ appearing in April or May. Pupation takes place in early June, usually in the rolled-up leaves of the oak or, less frequently, in cracks in the bark.

Few if any useful remedies can be applied towards eradicating this pest. Insectivorous birds will keep down the numbers to some extent.

The *Tineidæ* provide a few forestry insects. The Larch leaf-miner, *Coleophora laricella*, Hb., sometimes called the Larch Cigar-case Bearer, is sufficiently injurious to be deemed a pest. A larch tree attacked by the leaf-miner has such a characteristic appearance that the cause of injury is easily detected. Infested trees appear as though badly scorched; the tips of numbers of the needles are brown and withered. Not

only is the insect injurious in itself, but its attacks pave the way to further damage by a fungus causing larch canker.

The Larch leaf-miner is a small moth, rarely exceeding one-third of an inch in wing span. In general colour it is grey; head, thorax, and abdomen are grey, with a yellowish tuft at the apex of the latter. The wings are grey, the fore wings being darker than the hind ones, while both are fringed with lighter grey hairs. The females have their antennæ banded with white; these bands are absent in the male.

During the latter half of June, the moths may be seen on the larch trees, settled on needles and stem. They fly by day, and take to the wing on the slightest alarm. The female deposits a single egg on each needle. Yellow at first, these eggs turn grey later, and, in from a fortnight to three weeks, give rise to dark red larvæ, which tunnel into the larch needles without delay. The tunnelling begins at the apex and extends to approximately half the length of the needle. The portion which has been tunnelled turns brown and shrinks, thereby giving the infested tree its characteristic appearance. Now we reach a curious stage in the life-history of *Coleophora laricella*, whence its popular name of Larch Cigar-case Bearer is derived. The tunnelled portion of the larch needle resembles—is, in fact—a tube. This tube the larva lines with silk, and, having done so, cuts off from the undamaged portion of the needle. The tube, more correctly termed a case, forms a shelter for the larva, just as a

snail is protected by its shell, for, before severing the case from the leaf out of which it has been fashioned, the larva crawls inside. With his case on his back the larva goes to a sound needle, fixes the case thereto, and proceeds to feed, retiring to his shelter after feeding or when alarmed. On the advent of winter, the larva is still only about half grown, so he fixes his case to the stem or branch of the larch, or in some crevice in the bark, and hibernates till the following year. As soon as the young needles appear in the spring, the leaf-miner begins to feed on them voraciously. As a consequence, the larva soon outgrows its case, and, after the manner of its near relative the clothes moth, proceeds to enlarge its home. This is done by splitting along one side of the case and working in another piece of larch needle. When fully fed, the larva fixes its case firmly to a twig or to a needle and pupates within.

The pest is more prevalent when larches are thickly planted, than when there are only a few isolated trees. In the latter event, should the moths make their appearance, much good may be done by picking and destroying the cases in the winter. In larger plantations and forests this is impossible, and the infested trees should be thinned out and burnt, May being the most suitable time to carry out the work. Should this method be deemed too drastic, considerable good may be done by lopping off and burning the lower branches, for they are always more liable to attack than the higher ones. Spraying with paraffin emulsion, early in July, will have the effect of pre-

venting the females from depositing their eggs on the needles.

Certainly one of the most harmful moths in this country, from the forester's point of view, is the Goat moth, *Cossus ligniperda*, F. (fig. 2). It has a catholic taste and damages ash, elm, willow, oak, lime, alder, beech, birch, poplar, sycamore, walnut, and various fruit trees. Many entomologists aver that the ash and elm are most frequently and severely attacked: personal observation points to the willow as being the favoured tree. Be that as it may, there is no question that the larvæ of this handsome moth are exceedingly destructive.

The popular name of the insect requires some explanation. The larva emits a perfume which is highly reminiscent of the characteristic odour of the goat. So strong is this perfume that it is sometimes the first indication that one is in the vicinity of an infested tree.

The adults are large, heavy insects, measuring, in the case of the males, about two and a half inches from wing tip to wing tip, and, in the case of the females, approximately three and a half inches. The general colour of both sexes is brownish grey. The abdomen and thorax are brownish, head grey, hind wings grey-brown, and fore wings marbled with grey-brown and pale grey.

The females deposit their eggs during July in clusters of forty or so, usually in crevices in the bark, sometimes in the exit holes of the larvæ. These egg-clusters are rarely found more than four feet from the

ground: in colour they are brownish. In about three weeks fleshy-pink larvæ, about the shade of boiled prawns, emerge and at once burrow beneath the bark, where they remain for several months. After a time they tunnel into the hard wood of the tree, usually, but not invariably, taking an upward course. For three years they continue their larval existence, damaging the tree the while. During this time they change in colour to a dirty yellow laterally, with a rich mahogany shade dorsally. From time to time, the larvæ leave their tunnels and wander about on the surface of the tree. These wanderings usually occur in May, and during them the insects have been known to forsake the trees temporarily and damage other plants, notably dahlia roots. They may also leave the trees for the purpose of pupation in the ground, though this stage of the life-cycle usually takes place just within the opening of a tunnel. The cocoon of the Goat moth is a curious structure of silk and wood; internally it is lined with silk, externally it is covered with a layer of wood chips. A month after pupation the moths emerge.

When larvæ or adults are seen on the trees they should be destroyed; the pupæ also may easily be hooked out of the tunnels during the summer, by means of a bent wire. Where the insects are known to be in the neighbourhood, healthy trees should be smeared, in May, with a mixture of clay, paraffin, and soft soap. This mixture should be used freely, from the roots up to a height of eight feet, in order to prevent the moths from depositing their eggs or stray

larvæ from entering the tree. If, however, a tree has already been attacked, all the entrances to the tunnels should be plugged with clay, after having been treated with cyanide of potassium. Trees which are badly attacked should be felled and destroyed, otherwise they will only serve as shelters for the insects, from which they will eventually travel to attack neighbouring trees.

A moth which is as much a pest to the gardener as to the forester is the Mottled Umber moth, *Hybernia defoliaria*, L. (fig. 3), a member of the family *Geometridæ*. As its name implies, it is in the habit of defoliating the trees which it attacks, and they include such diverse species as the oak, elm, lime, beech, sycamore, birch, hornbeam, hazel, privet, whitethorn, apple, pear, plum, peach, apricot, and cherry.

The two sexes are easily distinguished in this species. The male has light chocolate-coloured fore wings, banded with darker brown, nearly two inches in expanse; its hind wings are lighter brown, and each one bears a darker brown spot in the centre. The female is a pale brown, ovoid, wingless creature. The larva is brown, marked on either side with a fine black wavy line. The habits of and treatment for this insect are similar to those of the Winter moth, described in the chapter dealing with orchard pests (*q.v.*).

The Buff-tip moth, *Pygæra bucephala*, L. (fig. 4), belonging to the *Notodontidæ*, is so named on account of the colour of its fore wings. In certain seasons the larvæ do considerable damage to various forest trees,

chiefly oaks and elms. They usually confine themselves to a single branch on a tree, completely defoliating it. This is not invariably the case, however, and in very bad attacks they spread all over the tree.

The adults are about three inches from tip to tip of their wings. The fore wings are silver-grey, mottled with white, the whole having a metallic sheen; the tip of each wing is buff-coloured. The hind wings are brownish white. On the thorax there is a conspicuous tuft of hairs. The larvæ, which are nearly two inches long when full-grown, are beautifully marked with yellow and black.

The females deposit their eggs, in early summer, on the under sides of the leaves of the food plant. When the larvæ first emerge, they all seek their food in proximity to the spot where they first saw the light of day. They rarely spread further than they can help from this spot, and, even when compelled to do so through lack of food, they collect together towards evening. This curious trait accounts for the fact that, as a rule, only one branch of the food plant is damaged. When fully fed, the larvæ descend to the ground to pupate; no cocoon or earth-cell is made.

After an attack, the trees should be well treated round the roots with gas lime. This will have the effect of keeping the pupæ in check. The larvæ, too, may easily be shaken into sheets placed beneath the trees, collected and destroyed.

Two beautiful moths which are inveterate enemies of growing trees are the Osier Clearwing moth,

Trochilium (*Sesia*) *bembiciformis*, Hb., and the Hornet Clearwing moth, *T. apiformis*, L. The former is a pest of the goat willow, *Salix caprea*, the latter of alder and poplar.

The Osier Clearwing moth measures about an inch and a half in the spread of its wings, which are transparent, after the manner of a wasp's wings. The anterior margin is very dark orange, and the veins are a rich brown. The antennæ are black, whilst the legs, head, and abdomen are brown, the last-named bearing bright yellow transverse bands. The larva is dirty white, with a brown head and legs; when full-grown it is about an inch in length.

The female deposits her eggs in fissures in the bark, towards the base of the tree, and a month later the larvæ emerge. They at once tunnel into the stem and, at first, confine their boring operations to one side of the tree, with the result that it is liable to break during a moderate wind. At a later stage the larvæ pass to the interior, where they remain till their third year, before pupating in a cocoon of wood chips, somewhat similar to that of the Goat moth. Very occasionally they pass to the ground to pupate. In the case of a severe attack, trees should be felled and destroyed. The moths also should be destroyed, when they are found sunning themselves on the tree trunks during the summer. The lower portions of the stems should also be smeared with the paraffin-soft soap mixture recommended for the Goat moth, to prevent oviposition by the females,

The Hornet Clearwing moth (fig. 5) is larger than

Fig. 3. Mottled Umber Moth,
Hybernia defoliaria, L.

Fig. 4. Buff-tip moth, *Pygaera bucephala*, L.

Fig. 5. Hornet Clearwing moth,
Trochilium apiformis, L.

bembiciformis, and is of a more general yellow colour. As its name implies, it is superficially much like a hornet. The two species may be easily distinguished by the fact that the former has a yellow patch on either side of the thorax, just behind the head, whilst the latter has a yellow band on the anterior thoracic margin. The wing venation of this moth, also, is more strongly marked than is the case with the Osier Clearwing.

Damage to trees is practically identical in both species, and the same remedies may be used in either case.

Hymenoptera

Three species of the genus *Sirex* are known in Britain; two of them are enemies of the forester. The Giant Wood wasp, *Sirex gigas*, L. (fig. 6), and the Blue Wood wasp, *S. juvencus*, L., have similar habits, so they may be conveniently considered together. The former damages Scots pine and silver fir; the latter, spruce and larch. In defence of the Wood wasps, it may be said that they do not, as a rule, attack healthy trees; seemingly they prefer sickly and felled timber. The females of both species are armed with long ovipositors, which, combined with a somewhat hornet-like appearance, always causes a certain amount of apprehension in those who see them for the first time. In truth, these insects are perfectly innocuous to human beings.

The female Giant Wood wasp measures nearly two inches from its head to the end of its ovipositor, and rather more in wing expanse. The head and thorax

are hairy and the abdomen smooth, with the exception of a broad, transverse, velvety band about its centre. The insect is black, but the abdomen is ringed with yellow on either side of the velvet band. The legs and antennæ are yellow. The male is smaller than the female and has no ovipositor. Its legs and abdomen are brown, except the first segment of the latter, which is black. The larvæ are cream-coloured, and when full-grown are rather more than an inch in length. The Blue Wood wasp may be described as a miniature edition of the preceding species, and can easily be recognised by its steel-blue colour. The larvæ are not nearly so plump as those of *gigas*, and are of a dirty-white colour.

The life-histories of the Wood wasps are not fully known. We are aware, however, that the females lay their eggs actually *in* the tissues of dead or sickly wood. The larvæ, which are said to be full-grown in about two months, tunnel towards the centre of the tree, then turn backwards, finally taking up a position just beneath the bark. Two years are spent in the larval stage, the adults emerging in the summer of the third year. Gillanders says: "One of the best consignments of these insects I ever had was captured by a miner, issuing from props within the coal-pit."

Trees which are known to be attacked by *Sirex* should be cut down, and the infested parts should be burned. As sickly trees only are usually concerned, the treatment is not quite so expensive as would otherwise be the case. Felled timber, which may also

suffer from the depredations of Wood wasps, should be destroyed when their presence is detected.

The Sawflies, *Tenthredinidæ*, include a number of species which are serious pests in the forest, orchard, and garden. They are called Sawflies on account of the peculiar structure of the ovipositor. We have just seen that the Wood wasps are provided with long ovipositors, which may be described as awl-like. The Sawflies, on the other hand, have ovipositors provided with minute saws, for the purpose of cutting slits in vegetable tissues in which the eggs are placed. It is not easy to state definitely which is the most injurious of the British *Tenthredinidæ*, but the Pine Sawfly, *Lophyrus pini* (L.) (fig. 7), has no mean claim to that distinction. This insect confines itself to young Scots pines.

The female is about three-quarters of an inch in wing expanse, with a dark brown head and thorax, whilst the base and apex of the abdomen are yellowish and the centre black. The male is rather smaller, with black head, thorax, and abdomen. The wings of both sexes are hyaline. The larvæ, which are about one inch in length, are greenish yellow, freely speckled with black.

In early summer the females deposit their eggs, splitting the young pine needles with their sawlike ovipositors and placing the eggs in the slits. In less than a month the larvæ emerge and feed on the surrounding needles. They are exceedingly voracious and conspicuously gregarious. Pupation takes place about July, and, of these pupæ, some produce adults

about a month later, others do not change their state till the following spring. The adults appearing in late summer produce a second brood of larvæ, which feed upon the youngest and latest-formed needles. The life-cycle of this brood is completed before winter, which is passed in the pupal stage.

Remedies for this pest are makeshifts at the best, especially where large areas are affected. Some good may be done by collecting and destroying both larvæ and pupæ. Insectivorous birds undoubtedly render much assistance in keeping the insects within reasonable limits.

Coleoptera

Two beetles of the family *Melolonthidæ* are enemies of the forester, the Common Cockchafer, *Melolontha vulgaris*, F., and the Horse-chestnut Cockchafer, *M. hippocastani*, F. The former is described in another chapter; the latter, though confined to the northern counties and Scotland, is fairly destructive, despite its restricted distribution. *Melolontha hippocastani* is about three-fifths the size of its commoner relative, and has a shorter, less acutely angled tail; in other respects the two species are very similar. Its attacks are by no means confined to the horse-chestnut, for it pays attention to practically all trees, particularly the Scots pine, *Pinus sylvestris*. The adults pair in April, and the eggs are laid on the ground a week to a fortnight later. When the soil is moist, the maximum depth for the eggs appears to be about four inches below the surface, but in dry ground they have been found

FIG. 6. GIANT WOOD WASP, *Sirex gigas*, L.

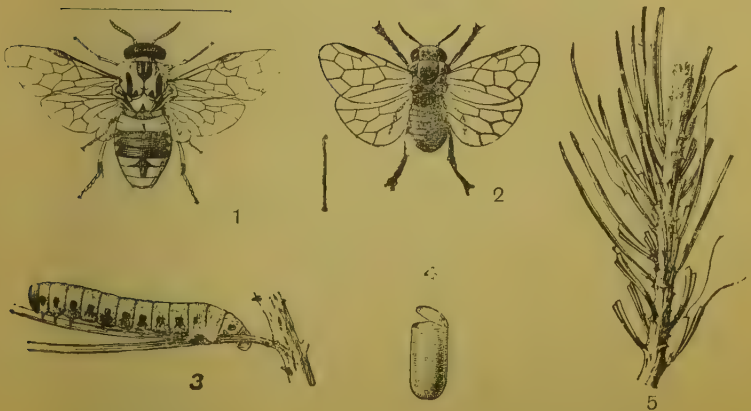


FIG. 7. PINE SAW FLY, *Lophyrus pini*, L. 1. MALE; 2. FEMALE; 3. LARVA; 4. PUPA; 5. TWIG DAMAGED BY THE LARVAE

buried more than a foot. The reason for this difference is that the eggs may not become dry. By July the larvæ emerge and commence a subterranean life of five years. At first they live upon the roots of young trees; from their fourth year they attack older trees. In August of their fifth year they pupate, eighteen inches below ground, and in a month to six weeks the adults emerge, but remain in hiding beneath the soil till the following spring.

Members of the family *Chrysomelidæ* are notorious for their leaf-eating habits, and are therefore harmful, or at anyrate not beneficial, to the forester. The Red Poplar-leaf beetle, *Melasoma populi*, L., and the Brassy Willow beetle, *Phyllodecta vitellinæ*, Kby., are perhaps the most notorious in this country. Both insects cause injury in the larval and adult stages. The results of attacks by the former beetle are well known: from June to August, poplars, aspens, and to a lesser extent the osiers, *Salix purpurea*, L., and *S. rubra*, L., may be observed with leaves curiously mutilated. Some have irregular round holes eaten out of them, others are skeletonised, only the veins remaining. Both kinds of damage are due to the Red Poplar-leaf beetle, the former to the perfect insect, the latter to the larva.

In May and June the female lays her eggs, to the number of one hundred and fifty, in clusters of ten or a dozen on the under side of the leaves of the food plants. The six-legged, dirty-white larvæ hatch a month later and at once begin to live on the leaves. When disturbed they exude a milky fluid with an

odour of bitter almonds. Feeding proceeds for a month before pupation takes place; the brownish-yellow pupæ are suspended, head downwards, from the leaves. During August, after a pupal period of ten days, the beetles emerge, and about October seek a hiding-place beneath old rubbish, leaves, moss, etc., where they may hibernate till the following spring. The beetles are about two-fifths of an inch in length, of a blue-black colour, with the exception of the wing-cases, which are brick-red, tipped with black.

All rubbish where the beetles are likely to hibernate should be collected and burned; in fact, traps consisting of dried moss may be placed beneath the trees in early autumn. Many of the beetles will hide in the moss, which should then be destroyed. Beating the trees and collecting the insects at the season of oviposition and emergence of the adults may do good, where such treatment is feasible.

The Willow beetle, like the insect we have just considered, spends the winter as a hibernating adult. The first warm days of spring are the signal to begin activities, and, after pairing, the females deposit their eggs, in clusters of about half a dozen, on the under sides of willow and poplar leaves. The larvæ, which soon emerge, feed on the under sides of the leaves, completely skeletonising them. They are of a dirty-white colour, and about a fifth of an inch in length; their favourite food plant seems to be the osier, *Salix viminalis*. The precise life-history of this insect is uncertain, but it is a well-established fact that the

adults are also injurious to osiers. The object desired in growing osiers is to obtain long shoots—rods, as they are called. This object is frustrated by the Willow beetle, which eats the growing points, with the result that the first year's rods are stunted, and the second year's crops suffer in the same manner; instead of growing to the desired length, a number of short lateral shoots are formed. The adult beetle is about a sixth of an inch in length or rather smaller, and of a blue-black colour, which in certain lights appears possessed of a bronzy sheen; its wing-cases are marked with longitudinal rows of punctures.

Where a small number of trees are infested, the beetles may be shaken into vessels containing paraffin. In the case of larger crops, spraying with Paris green is a useful remedy.

The family *Curculionidæ* is responsible for the worst beetle pest, so far as forestry is concerned. The insect in question is the Pine weevil, *Hylobius abietis*, L. F. Normally about half an inch in length, sometimes little more than half as much, these little weevils are black in colour, relieved with yellow bars on the wing-cases and some yellow scales on the thorax. They attack young coniferous trees for the most part, but will turn their attention to other species which happen to be in the vicinity of their favourite food plants. As is so often the case with common insects, there has been considerable controversy concerning the exact details of the life-history of the Pine weevil. The life-cycle is stated to extend over three years; it is also said to be completed in a little

over one year. "Where doctors differ," etc.! Our personal experience, however, is that the shorter period is the more accurate. The adults come out of their winter quarters in the spring, and the females deposit their eggs on the roots of felled trees. The larvæ emerge in about a month and feed, certainly till the following spring, when, after a short pupal period, the adults appear in the summer. The later batches do little harm in the year of their appearance, but seek warm winter quarters beneath undergrowth, where they can hibernate, ready to sally forth in the spring and begin operations early. The earlier batches of adults attack the bark of their food plants in characteristic manner. A tree which has been subject to damage by the Pine weevil looks as though it has been stripped of its bark by rabbits. In the case of old trees the injuries, though unsightly, are not serious. Young trees, however, suffer severely and are often killed, for in these cases the beetles usually damage the cambium in addition to the bark.

The beetle is not easy to eradicate. All herbage which could form a winter shelter for the hibernating individuals should be burned. Roots of felled trees which are attacked by larvæ should be taken up and destroyed; whilst a certain amount of good may be done by putting down strips of recently gathered bark to act as traps.

Rhynchota

Amongst the *Rhynchŏta* there are several destructive species, and none more so to the forester than the Felted Beech Coccus, *Cryptococcus fagi*, Baren. This Coccid is certainly more common at the present day than it was a few years ago, and in many parts of the country it does very serious damage. The only point in its favour is that it confines its attention to the common beech; the copper beech is almost immune. The Felted Beech Coccus is easily identified. From a distance, an infested tree trunk looks as though it had been whitewashed; at closer quarters it has the appearance of being covered with a light fall of snow. This white felt-like covering is formed of the excretions of the Cocci and, at times, is from a quarter to half an inch in thickness. When the insects are present in such large numbers the bark is so freely pierced that it cracks and peels off, eventually killing the tree. Contrary to the usual rule of insect pests, the Coccus causes most havoc amongst mature trees; young stock is rarely attacked.

The life-history of this pest is uneventful in the extreme. Many individuals never see the light; the more adventurous rarely stray far from their birth-place. Despite this, there are many debated points in the life-cycle, which can only be cleared by careful observation. If the "felt" be removed from a beech tree during the summer, the eggs, larvæ, and wingless females may usually be found. All three are yellow in colour. The larvæ, when first hatched, are very

active, their legs are sturdy, and they possess prominent purple-coloured eyes and five-jointed antennæ, terminating in a bifid bristle. The males are winged, but the females, which measure no more than one-twenty-fifth of an inch in length, are both wingless and legless. They are provided with mouth organs which are modified into long thread-like structures, serving at once as attaching and sucking organs. The sole mission in life of the female Felted Beech Coccus is to increase her kind.

Probably the females oviposit in the summer months and some of the eggs hatch in the autumn, whilst the majority do not give rise to larvæ till the following spring. The autumn-hatched larvæ remain active during the winter, hidden the while beneath the felted mass of excretion. In the spring, both sets of larvæ soon become less active and, plunging their beaks into the bark of the host tree, suck up its juices and simultaneously become covered with a white waxy secretion which exudes from their dorsal pores. Eventually they moult and gradually transform into wingless females, surrounded with a felt-like covering of waxy wool, in which the relatively large eggs are deposited. The waxy covering is impervious to water, but is washed off by heavy rain, only to be reformed again later. Heavy rain, in fact, is harmful to the Cocci, and the drier the weather the more rapidly they increase. The pest is carried from tree to tree by the wind; distribution may also be accidentally brought about to a certain extent by birds, but wind is the chief distributing agent.

Cryptococcus fagi is eradicated without much difficulty, and, were it not for the fact that the pest is often allowed to attain serious proportions before any great effort is made to combat it, there would be little difficulty in keeping it in check. Spraying with caustic alkali wash in winter, or with paraffin emulsion in early autumn or spring, is quite satisfactory. Gillanders mentions two remedies, the one highly successful, the other eminently novel. He says: "Take about half a gallon of soft water, boil, and dissolve about one pound of soft soap and about one pound of common soap; add a handful of sulphur, one pint of paraffin, and about the same quantity of turpentine. Then add about four gallons of soft water to this mixture. Churn well with a syringe, and when cold, store away in a stoppered barrel to prevent evaporation. Apply with a whitewash brush about May, just as the larvæ are hatching out, but before application churn well with the syringe, to ensure the mixture of the ingredients." The second remedy, of which we have no experience, is conducted in the following manner. "With an inch auger bore three holes at about equal distance right into the centre of the trunk, about three feet from the ground, and sloping slightly towards the root of the tree. Into these holes place as many flowers of sulphur as can be conveniently got in, and then cork them firmly up with a plug of soft wood. This should be done in the autumn, and will be found successful. It was first adopted about thirty years ago, and the trees which were then operated on are now in comparatively good condition."

A closely related scale, the Felted Ash Coccus, *Apterococcus fraxini*, Newst., as its popular name implies, is a pest of the ash. It is not nearly so common as the Beech Coccus and, when present, is not so harmful. It merits a few words here on account of the fact that the male is wingless and, in this respect, differs from other male Coccids, which are all winged. A tree attacked by the Felted Ash Coccus does not present a whitewashed or snow-covered appearance, but it is dotted somewhat sparsely with white spots, where the insects are present. Trees with smooth bark are most liable to attack.

The males, to which chief interest attaches, may be found actively running about on the trees during early autumn. They are orange-red in colour, with black eyes. The females are bright red, and, unlike those of the Beech Coccus, are provided with legs which, however, they seldom use. Remedies which are successful against the Felted Beech Coccus may also be used against this insect.

We need hardly remark that our brief survey of some of the pests of British forests includes but a tithe of the insects against which the forester must be constantly on guard. Volumes have been written on the Galls of a single tree—the oak. Millions of words have been penned anent the Aphids. To try to include everything in a few pages is to attempt the impossible. Our examples are chosen in the hope of portraying the various ways in which diverse pests do harm to different organs of our forest trees.

CHAPTER III

PESTS OF FRUIT TREES

A VERY large number of insects, which must be included under the heading of orchard pests, are also equally notorious in the forest. In these pages it is impossible to include the same insects under both headings; therefore we would warn our readers that our inclusion of an insect in one or the other chapter is by no means an arbitrary proceeding.

As in the case of forest trees, orchard stock, either in the shape of bush or tree fruit, is liable to damage and destruction in practically every organ. Naturally, perhaps, the leaves are the greatest sufferers; but branches, main stems, and roots are by no means immune.

LEPIDOPTERA

One of our handsomest British moths, the Wood Leopard, *Zeuzēra æsculi*, L. (fig. 8), is by no means a welcome visitant to our orchards. The insect has earned its popular name from a fancied resemblance to the leopard; both are spotted, and there the resemblance ends. Its scientific name was bestowed upon it because the chestnut was believed to be its favourite tree. In addition, it damages elm, cherry,

walnut, plum, pear, and apple, so that it has every claim to be included amongst our orchard pests.

The adults are white, spotted with dark metallic blue. There are six of these dark spots on the thorax. The female measures nearly two and a half inches in wing span, and the male is smaller. The adults are active during the summer, and the female deposits her orange-coloured eggs on the bark of the tree which she has selected as a home for her larvæ. In about a fortnight hatching takes place, and the newly arrived larvæ tunnel into the wood. They are cream-coloured, slightly bristly, and have brown heads. In less than a year they are full-grown and some two inches in length. Before pupating, they travel back to just below the bark, where they spin a cocoon of silk, freely covered with wood particles.

When the holes made by the larvæ are detected, they may be treated in a similar manner to those of the Goat moth. Often, however, there is no visible sign of external damage till the tree begins to die. In this event the affected branches should be cut off and destroyed, taking care that sufficient is severed to include the destructive larvæ.

A lepidopterous pest with larvæ of wood-boring habits quite distinct from those of the Wood Leopard moth is the Currant Clearwing, *Trochilium* (*Sesia*) *tipuliformis*, L. Currants of all kinds are attacked, though black ones seem to be preferred; the larvæ have also been taken from the gooseberry.

The adults are small, rather less than three-quarters of an inch from wing tip to wing tip, and their general

FIG. 8. WOOD LEOPARD MOTH,
Zeuzera aesculi, L

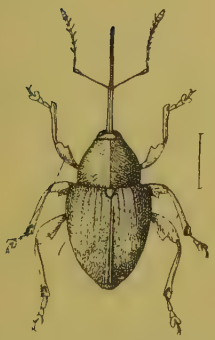


FIG. 9. NUT WEEVIL,
Balaninus nucum, L

colouring is dark metallic blue. On either side of the thorax there is a yellow stripe, and there are four narrow, yellow abdominal bands in the male and three in the female. The wings are transparent, with the exception of the veins, margins, and tips. In early summer the females deposit their pale yellow eggs, one on each currant stem, near a bud. In less than a fortnight the very minute cream-coloured larvæ appear, and after taking the precaution of eating the egg shells which they have just vacated, they tunnel into the pith. They work up and down this tissue and remain hidden within the stem during the winter. Pupation takes place in the spring. The pupæ are fairly active, for, before the adults emerge, they manage to wriggle their way partly out of the original holes made by the larvæ. According to Theobald, emergence usually takes place in the early morning. This insect is common wherever currants are grown, and, if dead shoots are split during the winter, the larvæ will invariably be revealed in the space normally occupied by pith. Pruning of all such damaged twigs is the one remedy of any avail against this moth.

Very similar in appearance to the Currant Clearwing, and somewhat akin in habit, is the Apple Clearwing, *Trochilium* (*Sesia*) *myopiformis*, Bork., which may be distinguished from the species we have described by, amongst other things, a broad red abdominal band.

However anxious one may be to do so, it is not easy to state which is the most harmful insect to any par-

ticular crop. Local conditions may exert a considerable amount of influence. Among orchard pests we should be inclined to vote for the Codling moth, fully described in *Insects and Man*, and the Winter moth, *Cheimàtobia brumata*, L. The family *Geometridæ*, to which this insect belongs, also includes the Mottled Umber moth and the March moth, *Anisŏpteryx æscularia*, Schiff. The females of both these species are wingless.

The forester might claim the Winter moth as his own, for it is an enemy of practically every British deciduous tree. In the orchard, it attacks apple and plum when they are available; failing them, pear, peach, raspberry, currant, gooseberry, and walnut do not come amiss. It will even migrate to the flower garden and damage rose trees.

The males, which measure about an inch and a quarter in wing span, have pale brown hind wings and darker brown fore wings, transversely banded with chocolate. The fore wings vary considerably in colour from a grey-brown to a subdued orange. The females, which possess the merest rudiments of wings, are of a uniform grey-brown colour and are very variable in size. A peculiarity of these insects, and the one which has earned them their popular name, is that the adults appear during the winter months. They have been taken from early autumn to early spring. The males usually appear before the females. The latter make their way to their selected trees without delay and, crawling up the stems, deposit their eggs usually near a bud. Each female produces

about three hundred and fifty elongate, greenish-coloured eggs, which turn orange-red before the larvæ emerge. The larvæ appear at about the time when the buds burst, and proceed to attack them as they open. Dark-coloured at first, they become green as they grow older, but the shade of green varies considerably. After feeding upon the buds for a time, the caterpillars migrate to the blossoms, which they weave together by silken threads. Still later in the season they attack the fully expanded leaves and even the fruit. When fully fed and measuring about an inch and a half in length they pass to the ground, where, about three inches below the surface, they pupate in silk-lined earthen cocoons. Occasionally the cocoon is made on some plant near the ground, instead of below the surface.

The closely allied March moth appears rather later in the season, as its popular name implies. It is not so destructive as the Winter moth, for its usual food plants are the blackthorn and whitethorn; it does, however, attack apple, plum, damson, pear, walnut, and the forest trees oak, elm, lime, and Spanish chestnut.

As we have already remarked, the female is wingless, of a grey-brown colour, with a peculiar tuft of long hairs forming a tail. The male is most active in the evenings. The wing expanse is about an inch and a half; the fore wings are grey-brown with a dark spot on each, near the front margin. The hind wings are paler, and a dark wavy line runs across both fore and hind wings.

The eggs are laid in incomplete rings round twigs of the food plant, and are freely intermingled with hairs from the peculiar tail of the mother moth. The larvæ emerge in the spring; they are bright green to yellowish green, and much more slender than those of the Winter moth. They are fully fed in the summer, and then measure about an inch in length. At this period they pass to the ground and form a cocoon very similar to those of *brumata*.

The fact that the females of these allied moths are wingless has been taken advantage of by fruit-growers, and their attacks may be almost wholly avoided by grease-banding. The process consists in fastening round the trees, and the supporting stakes if present, a band of strong grease-proof paper. About two feet from the ground is a good position. The bands are then covered with grease, so that all the females which crawl up the trees to lay their eggs will be entrapped and unable to pass beyond the band. Two precautions are necessary for the efficient operation of grease-banding — the grease must not be allowed to dry, it must be renewed when necessary; entrapped insects must not be allowed to accumulate on the bands to such an extent that the more fortunate late comers may crawl in safety over their bodies.

We have remarked that their attacks may be almost wholly avoided by grease-banding: some few females do, as a matter of fact, pass the best-made bands, being carried to the trees by the winged males. These individuals, however, are so few in

number as to be negligible; careful grease-banding will do all that is necessary. The bands should be in position by the end of September, and should be kept efficient till mid-January for the Winter and Mottled Umber moths, and till early April for the March moth.

Coleoptera

Though the results of the work of destructive insects are often apparent at dessert, few of the insects themselves find their way to the dinner-table. We are all, however, familiar with the grubs possessed of the uncomfortable habit of lurking in cavities of raspberries, and with those which so frequently come to light when filberts are cracked. The former are the larvæ of the Raspberry beetle, *Byturus tomentosus*, F., and the latter, those of the Nut weevil, *Balaninus nucum*, L.

The Raspberry beetle is a serious pest of the raspberry, blackberry, and loganberry, whilst the adults also feed on hawthorn, apple, and pear blossoms. The beetles are small, not more than a seventh of an inch in length, of a dark brown colour, which, in the younger stages at any rate, is concealed by a yellowish pubescence. The legs and antennæ are yellowish brown. The adults appear in the late spring and early summer, just at the time when the blossoms are opening. Some of these they proceed to destroy by feeding upon them, being, like most beetles, especially active on warm, sunny days.

In other blossoms the females deposit their eggs,

one in each blossom. Immediately the larvæ hatch they bore into the receptacle—the structure which occupies the centre of the ripe raspberry. These grubs vary in colour from white to yellow and are small, measuring but one-fifth of an inch when full-grown. Once in the receptacle, the larvæ feed on the interior of the developing fruit at their leisure, with the result that the fruit never fully forms, or does so only on one side. From time to time the grubs will pass to other fruits, entering between the fruit and the receptacle. When ready to pupate, they either pass to the ground or seek out some convenient hiding-place on the canes or supporting stakes. Winter is passed in the pupal stage.

A number of the pupæ will be destroyed during the autumn pruning if the cut portions are burned. The beetles may be shaken off the canes in large numbers on dull days and collected on tarred boards; the ground too may be treated with paraffin and ashes, or soot and lime in the early spring. Arsenate of lead spray, at the time of the blossoms opening, has proved effective. It must never be forgotten that Raspberry beetles may migrate from wild blackberries, so that if these plants grow in the vicinity of raspberry canes they should be destroyed when feasible.

The Nut weevil (fig. 9) attacks the cob, filbert, hazel, and oak. The adult is chocolate-coloured and is covered with a yellow pubescence, which becomes paler as the beetle grows older. Both males and females are active on the wing, and when alarmed drop to the

ground and feign death — a favourite weevil habit. They appear about midsummer, and the females proceed to deposit their eggs in the young nuts.

At the end of the long snout, typical of the weevils, there is a biting mouth. With the aid of this organ, the female bores a neat hole in the young nut. In the hole a single egg is laid and pushed well into the interior of the nut by the mother beetle, who uses her snout for the purpose. In a little over a week a soft, slightly curved, cream-coloured grub appears. The larva is only one-third of an inch in length when full-grown, and is decidedly plump for its length; with its hard brown head and slightly hairy body it is, however, an all too common object. Nourishment is obtained at the expense of the kernel, which is usually attacked on one side only, though often little remains within the shell except the grub and its frass, by the time the former is fully fed. When this stage is reached, the grub bores an exceedingly neat round hole in the hard nut shell, in diameter about the same as its head, but smaller than its body. Here we see the utility of its extreme softness. Were the grub clothed with a harder coat, a larger hole would be necessary to enable it to escape; as it is, however, an exit is made, by dint of violent struggles, from a hole which is literally too small. The winter is passed in the larval state, pupation taking place in the early spring.

Spraying with arsenate of lead is as good a remedy as any for this pest. Owing to the peculiar habits of the adults, a number may be caught by shaking the

trees over tarred boards; whilst turning over the ground below the trees, in winter and early spring, exposes a number of the pupæ and hibernating larvæ to the attacks of birds.

Beetles of the family *Scolytidæ* are all injurious to wood, either living or dead. The species with which fruit-growers are most concerned is the Fruit Bark beetle, *Scolytus rugulosus*, Ratz. (fig. 10); it is a pest, moreover, which appears to be becoming more prevalent. Apple and plum are its favourite trees, but pear, quince, apricot, peach, and nectarine are also attacked. Externally, the work of these beetles may easily be detected owing to the numerous holes in the bark through which they have escaped; a badly damaged tree looks as though it had received several charges of fine shot. The younger branches and twigs soon lose their bark, which peels off in strips owing to the activities of the insects.

The minute beetles, little more than a tenth of an inch in length, are very dark brown, and their wing-cases are marked with longitudinal striations. It is probable that there are three broods in a year.

The adults appear in the late autumn or early summer. The females bore through the bark to the wood, and there tunnel for a considerable distance between the bark and wood (fig. 11). At the sides of these tunnels, which are made partly at the expense of the wood and to a lesser extent in the bark, the eggs are deposited. The exact number produced by each female is not known. The larvæ are white, legless creatures which pass the winter beneath the bark and

FIG. 10. FRUIT BARK BEETLE, *Scolytus rugulosus*, RATZ.
1. ADULT; 2. LARVA, NAT. SIZE AND MAGNIFIED;
3. STEM DAMAGED BY THE BEETLE

FIG. 11. TUNNELS MADE IN WOOD BY FRUIT BARK BEETLES

do damage all the time by feeding on the wood. When fully fed, they hollow chambers in the wood in which to pupate, and when the mature insects emerge from the pupæ, they find their way to daylight by eating their way through the bark, forming the characteristic shot-holes as they do so.

There are few, if any, efficient remedies to control this destructive little pest, but much can be done in the way of prevention, if all trees which are attacked—not only growing trees, but stumps and felled trees—are destroyed. Such trees simply act as shelters, from which the beetles will issue to attack healthy trees.

Hymenoptera

A goodly number of Hymenoptera are orchard pests, and of them the Sawflies are the most important. The Pear and Cherry Sawfly, *Eriocampa limacina*, De Geer (fig. 12), is an all too common pest, with an interesting life-history and a curious larval stage, which has earned it the name Slugworm. As may be surmised, pear and cherry are the favoured trees, but quince, oak, and almond are also attacked. The insect is by no means confined to Britain, but also occurs in the United States, New Zealand, and South America; in Europe it has been known for more than a century and a half.

The adult measures about two-thirds of an inch in wing span and is shining black, with the exception of the wings, which are hyaline, transversely banded with a smoke-coloured area, and the extremities of the hind legs, which are yellow. The larva, when

newly hatched, is pale yellow, but it quickly assumes a bottle-green hue, owing to the secretion of a greenish slime. The anterior portion becomes so swollen that the head is hidden in dorsal view. The whole appearance of the larva is strongly reminiscent of a slug; it is, however, provided with twenty legs. When nearly full-fed a considerable change in appearance takes place; the bottle-green colour gives place to a greenish yellow, and the slime-covered shining skin becomes dull and wrinkled.

In the summer the female makes a semicircular slit, with her saw-like ovipositor, in the epidermis of the leaf, usually on the lower surface, sometimes on the upper. In this slit she deposits a single white, oval egg, which hatches in a week. The larva passes to the upper surface, where it feeds in a characteristic manner, by eating away the upper epidermis and the soft parts within—mesophyll—leaving the lower epidermis undamaged. Where the damage is extensive, the leaves are so destroyed that the tree sends forth a second crop, becoming much weakened in so doing, with the result that the fruit is ill formed or not formed at all. In about a month the larva is fully fed and about half an inch in length; it then passes to the ground and pupates a little below the surface. A second and more destructive brood appears in late summer and continues its activities through the autumn. Winter is passed below ground in the larval stage.

Spraying the trees with arsenate of lead is an efficient remedy. Dusting with powdered hellebore

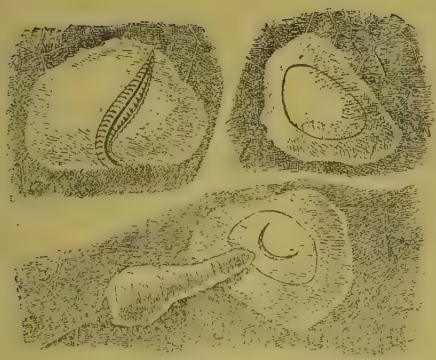


FIG. 12. PEAR AND CHERRY SAWFLY, *Eriocampa limacina*, DE G. (*a*) CUT IN LEAF SHOWING SAWLIKE OVIPOSITOR OF FEMALE; (*b*) THE SAME AFTER DEPOSITION OF THE EGG; (*c*) AFTER EMERGENCE OF LARVA

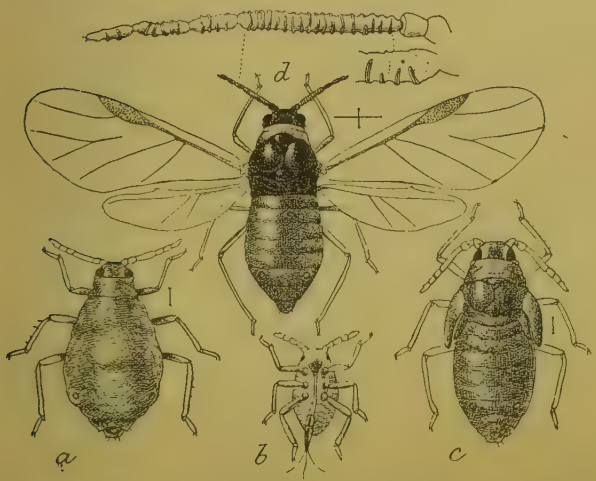


FIG. 13. WOOLLY APHIS, *Eriosoma lanigera*, HAUSM. (*a*) AGAMIC FEMALE; (*b*) YOUNG NYMPH; (*c*) LAST NYMPHAL STAGE OF WINGED APHIS; (*d*) WINGED AGAMIC FEMALE AND ITS ENLARGED ANTENNA. IN EACH CASE THE WAXY SECRETION HAS BEEN REMOVED

or with soot and lime is also effective. The latter may also be spread under the infested trees at the time when the larvæ are ready to pass to the ground. Where only a few trees are concerned, future attacks may be prevented by removing a layer of the surface soil beneath them in winter, thereby taking up the hibernating larvæ.

Four species of Sawfly are known to damage the gooseberry in Britain. The commonest and most destructive is the Gooseberry and Currant Sawfly, *Nematus ribesii*, Scop. Its favourite food plants are the gooseberry and red currant, but the black currant is not immune.

The female is orange-yellow, marked with black; the hyaline wings span nearly three-quarters of an inch and are iridescent. The male, which is rather smaller than the female, may be described as black with yellow markings. The adults appear in late spring, and the female deposits her pale-green eggs, to the number of forty, on the under sides of the leaves, along the veins. Each egg is placed separately in a slit in the epidermis, made by the saw of the female, but is not completely hidden in the leaf, as is the case with the ova of the Slugworm. In little more than a week the larvæ emerge. At first they are green, freely speckled with black spots, and with black heads. While young, they feed in company, devouring the leaves voraciously; later they spread over the bushes, but their appetites show no signs of abating. When almost fully fed and the last moult has taken place, the larvæ change considerably in

appearance. Some become pale yellow, others a bluish-green colour, with an orange patch fore and aft, the spots have vanished, and their heads are green and brown. At this stage they measure about two-thirds of an inch in length. Most of the larvæ pupate in the ground; some, however, fix their cocoons to vegetation lying on the ground. The cocoons are as variable in colour as the larvæ; they may be various shades of brown to dirty yellow. The duration of subterranean life varies according to the season. The first brood of the year passes to the pupal stage, which lasts about a fortnight, immediately the cocoon is formed. The last brood remains in the larval stage, within the cocoon, throughout the winter, pupation taking place in the spring. The number of broods in the year is a debated point; probably the weather exerts a considerable influence. Personally, we have found three to be the usual number in a favourable season.

When a small number of bushes are affected, the Sawflies may be kept in check by hand-picking and destroying the young larvæ, while they are still feeding in company, and by removing and destroying the surface soil below the bushes in the winter, thus getting rid of the hibernating larvæ. In larger orchards, the earlier attacks may be dealt with by an arsenate-lead spray, and the later ones by weak paraffin emulsion. Both these substances will kill the larvæ, but the former is exceedingly poisonous, and a month must be allowed to elapse after its use before the fruit is gathered.

Diptera

The owner of a pear tree, who is unaware of the ways of certain insect pests, may one day be delighted to observe some of the young fruitlets apparently making rapid growth. Later, when these abnormally developed pears become deformed into every conceivable shape, the orchardist will become aware for the first time, maybe, that all is not well with his crop. Such rapid growth and subsequent deformation point to an attack by the destructive Pear Midge, *Diplōsis pyrivora*, Riley, a gall-fly belonging to the family *Cecidomyiidæ*. The pear is the only tree which is attacked, and a few varieties appear to be immune. Theobald mentions "Honey" and Beurre Easter as immune varieties, and Glou Morceau and Comice as varieties which are seldom attacked. This suggests that something might be done in the way of producing other immune varieties.

The midge is only about a tenth of an inch in length, but is somewhat variable. In colour it is very dark grey, with the exception of the legs, which are yellowish. The thorax is marked with a pair of lighter grey stripes; the wings are cloudy and their hind margins are edged with black hairs. The female may easily be distinguished from the male by her long ovipositor, which is as long as her body; she is also lighter in colour than the male.

The adults appear on the wing in the spring, when the pear blossoms are opening. Oviposition takes place without delay, and the long ovipositor with

which the female is provided enables her to place her eggs well within the blossoms, usually on the anthers. In order to do this, she pierces a hole through the calyx and corolla of the bud. Each female deposits a variable number of eggs, from a dozen to nearly fifty, in exceptional cases; they are white and elongated. In less than a week the minute, dirty-white larvæ emerge and tunnel in all directions within the developing fruit. With such energy do they work and so large are their numbers, at times, that the whole interior of the fruitlet is eaten away, with the result that it contains only a mass of maggots mingled with frass. At this stage the fruit, which may still remain on the tree or may have fallen to the ground, cracks and the larvæ are enabled to escape.

Although fully fed when they leave the fruit, and measuring no more than one-seventh of an inch in length, they pass below ground to a depth of rather more than an inch, pupate, and remain in that state till the spring.

In small orchards, where bush fruit alone is grown, the best remedy is to hand-pick and destroy all the infested fruitlets, with the contained larvæ. Where large trees are concerned this method is impracticable, for the midge attacks blossoms on the highest branches; in large orchards, too, hand-picking cannot be carried out cheaply. Late frosts, the bane of the fruit-grower, are not an unmixed evil, for, over and over again, it has been shown that eradication of the Pear Midge coincides with the destruction of the pear

blossom. Poultry are effective in destroying large numbers of the larvæ as they fall to the ground, and, where the attack is virulent and Spartan remedies are necessary, the crop must be sacrificed by spraying the trees heavily with Paris green just before the blossoms burst.

Rhynchota

There is one orchard pest which is so common that it must surely be known to everybody who has had any dealings whatever with fruit trees, and it is as harmful as it is common. We refer to the Woolly Aphis, *Eriosōmă lanigera* (Hausm.) (fig. 13). Practically every old and unkempt orchard can show apple trees more or less seriously damaged by this pest. The tufts of bluish-white, cotton-wool like colonies on the stems are all too common wherever apples are grown, not only in this country, but the world over. As frequently happens in the case of the commonest insects, its life-history is not fully understood. The insect was described so long ago as 1802; it was first recorded in England in 1787, and was stated to be of American origin—hence another of its popular names, American Blight. Baker believes the insect to have been originally an elm and *Cratægus* feeder which later adopted the apple. He believes that "the original home of *Eriosoma lanigera* was throughout the great limestone regions of temperate America. When these regions were planted to apple, the aphis adopted these trees as its secondary host, and by means thereof has spread throughout the

world. Its habits have been altered to suit both host and climate in many countries, but in its native home it still continues its regular cycle of alternation."

There are two forms of Woolly Aphis, an aerial form which attacks the stems and a root form, a fact which tends to complicate the already complex life-history. The presence of an aerial colony on a tree is revealed by its cotton-wool like appearance, due to a secretion destined to protect the aphides. This form has also been found in the core of the fruit.

Careful examination of an aerial colony will reveal the presence of plum-coloured forms with reddish-brown legs; these are the "mother queens," which, without the assistance of males, produce not eggs, as might be expected, but living young, thus effecting a great saving in time. The young, yellow at first, but later becoming plum-coloured, live for a time with the "mother queens," but, after the first moult, they wander to other parts of the tree, secrete the woolly protection, and proceed to the business of the rapid production of living young. Towards autumn new forms arise, minute, orange-coloured, wingless males and females (fig. 14), the latter laying eggs instead of producing living young. Each of these females (fig. 15), after crawling to the base of the tree, lays a single egg just above the ground, from which a "mother queen" emerges in the spring. At certain periods during the summer there arise winged females, each capable of producing living young. These fly to other trees and so spread the pest.

In addition to these aerial forms there are subter-

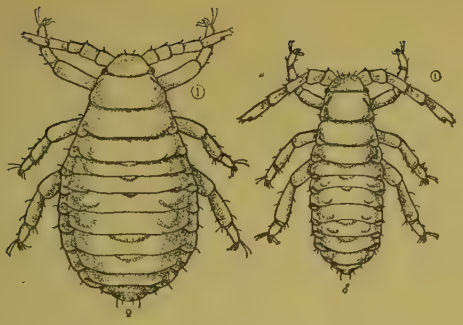


FIG. 14. WOOLLY APHIS SEXUAL FORMS.
1. FEMALE ; (2) MALE

15. WOOLLY APHIS SEXUAL FEMALE, SHOWING EGG BEFORE AND AFTER EXTRUSION

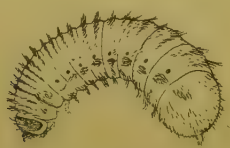


FIG. 16. ROSE CHAFER LARVA.
Cetonia aurata, CURTIS

ranean ones, which attack the roots; they travel up the stem from time to time, and in this manner renewed outbreaks of the pest arise, after the aerial forms have been killed. Both forms must be treated to effect a complete cure.

Damage to the trees by Woolly Aphides is twofold. Numbers of the insects sucking the sap, energetically and continually, lower its vitality and, furthermore, cause serious wounds, which become vulnerable spots for attacks of "canker."

To eradicate Woolly Aphides, treatment must take place above and below ground simultaneously. Aerial colonies should be forcibly sprayed with a mixture of soft soap and quassia, to which about three per cent. of paraffin has been added. Force is necessary to penetrate the woolly secretion and reach the insects below. The subterranean colonies should be attacked when the soil is dry, and three ounces of carbon bisulphide should be injected below ground about two feet from the tree on each of the four sides by means of a Vermorel injector. The liquid itself must not be allowed to come in contact with the roots; its vapour will kill the insects without damage to the tree. The branches, when attacked, may be treated with the zinc-lead mixture mentioned in the Appendix, whilst the roots may be uncovered in winter and treated either with water almost at boiling-point, or with a mixture of equal parts of sand and naphthalene, afterwards, of course, being covered again with soil.

Efforts might be directed to the production of apple stocks immune to all aphis. Froggatt, describing

a successful experiment in Australia, says: "The practical application of producing blight-resisting apple stocks is due to the experiments of Messrs T. Lang & Co., the well-known Victorian nurserymen, in 1860–70, who used a variety known as the 'Majetin,' their attention having been drawn to this stock in Lindley's *Guide to the Orchard*. They also introduced the 'Northern Spy' from America, and proved them to be perfectly immune from the attacks of this insect; and these facts are so well established that now, instead of the old haphazard methods of using any kind of apple stock, all other varieties of apples are grafted upon these and other blight-proof stocks. It is, therefore, only a question of good cultivation and time, when all the old infested apple orchards have run out, that woolly aphis will die out in Australia; for, unlike America and Europe, we have no species of wild crab apples growing in our scrubs or forests that prolong its existence."

CHAPTER IV

PESTS OF THE FLOWER GARDEN

THREE of our commonest ornamental trees—laburnum, lilac, and holly—are subject to attacks of leaf-miners, insects which burrow into the tissues of the leaves below the skin and cause unsightly blisters. Not only do these insects disfigure the trees, but, when present in quantity, they destroy the power possessed by all green leaves of assimilating food for the plant. Careful observation will show that these leaf-miners are quite common. Year by year they may do little real harm, then one season, without apparent reason, they will increase to such an extent as to become a real pest. Climatic conditions, favourable to the rapid increase of the insects, may account for these fat years, or, again, they may arise from a dearth of parasites which in normal seasons keep them in check. Whatever the cause, the moral is clear: methods of eradication should be taken even in the lean years.

The Laburnum leaf-miner, *Cemiostoma laburnella*, Martini, is a moth belonging to the family *Tineidæ*, the family of the well-known clothes moth. Small, irregularly circular blisters, greenish when recently formed, grey when older, on the laburnum leaves

first disclose the presence of this pest. The female deposits her eggs on the under side of the leaf; near the midrib, according to some authorities. When the larvæ emerge they bore through the epidermis of the leaf and tunnel through the tissue below for a short distance. At the end of the tunnel they form a more or less circular cell by eating away the leaf-tissue, and in this manner the blister arises. This takes place, as a rule, about the end of June. The larvæ remain within this hiding-place till fully fed, when they are about a quarter of an inch in length, pale greenish in colour, with deeply indented segments, grey heads and legs, brown jaws, and two grey marks on the second segment. Pupation takes place on the surface of the leaf, within a white cocoon, pointed at either end. During July, August, and September the moths emerge. They are small, only a quarter of an inch from tip to tip of the expanded wings, but of almost dazzling whiteness, with yellowish marks and a purple spot near the tip of each fore wing. Unless disturbed, they fly only in the evening, resting during the day beneath the leaves, on the stems, or on neighbouring trees, fences, or palings.

The females lay their eggs on the under surface of the leaves, just as their maternal parents did, and the same procedure takes place up to the point of the completion of the larval stage. In the case of this second brood, however, pupation does not take place on the leaves. These pupæ must survive the winter, if the race is to be continued, and were they affixed to the leaves they would have a poor chance of doing

so, at leaf-fall. Each fully fed larva of the autumn brood lets itself down by a silken thread either to the ground or to the tree trunk near the ground, and there, below some rubbish or in a convenient crevice, pupation takes place, and in this stage the winter is passed.

When the attack is not severe, the picking and burning of the blistered leaves is an obvious remedy. Any rubbish which may have collected at the base of the trees should be swept up and burned, and the stems should be treated with a caustic alkali wash; in this way the winter pupæ are destroyed. While old and otherwise healthy laburnum trees are apparently little affected, even by comparatively severe attacks, young nursery stock and unhealthy mature trees are seriously checked by the work of the leaf-miner. In any event the disfigurement detracts from the value of the tree for ornamental purposes.

The Lilac leaf-miner, *Gracilaria syringella*, F., has been known to entomologists for considerably more than a century and a half. Like the Laburnum leaf-miner, it belongs to the *Tineidæ*, and produces two broods annually. Unlike this insect, however, it attacks other trees in addition to the one from which it takes its name, chiefly privet and ash; moreover, its attacks are not always made in the same manner. Sometimes it tunnels into the leaves and causes blisters, sometimes it rolls them. Lilac appears to be the favourite food plant.

Towards the end of May and during June, the female lays her eggs in clusters either on the leaf-stalks or on the upper surface of the leaves. In a

week or so the larvæ emerge and usually bore at once into the leaf, tunnelling through the tissue and forming blisters after the manner of the Laburnum leaf-miner, except that the blisters in this case are more irregular in outline, larger, and may contain as many as a dozen larvæ. At first the larvæ are almost transparent. When nearly full-fed they are about a quarter of an inch in length, of a greenish colour, with brown heads and much-indented segments. By this time, however, they have left their shelter within the leaf and, either on the same leaf or one near by, they complete their larval feeding. As a protection during this time they roll up the leaf from the under side, either apically or laterally, and eat away the lower epidermis and leaf-tissue which surrounds them. They usually spin their white cocoons in some crevice in the tree trunk; sometimes, however, they do so in the axils of the leaves, the angle between the leaf-stalk and the stem.

In ten days or a fortnight the moths emerge. They are somewhat variable in size, but average about half an inch across the wings. The general colour of the fore wings is brown, with six transverse bands of golden yellow; the hind wings are grey. They fly only about sunset, unless disturbed. The second brood differs but little from the first. Theobald has observed, however, that the larvæ of the first brood blister the apices of the leaves, for the most part, while those of the second brood attack the sides, base, or centre. Winter is passed in the pupal stage, in cocoons on the stem.

Remedial measures are the same as those recommended for the Laburnum leaf-miner. Removal of debris near the base of the tree will not eradicate the pupæ, however, for none of the larvæ pass to the ground to spin their cocoons.

An interesting case of a moth which periodically pays attention to the flower garden, with disastrous results, is mentioned by Collinge; it is the Clouded Drab moth, *Tæniocampa incerta*, Hufn., a member of the family *Noctuidæ*. As a rule the larvæ feed upon ash, poplar, sallow, willow, elm, lime, currant, and laburnum. In more than one instance, however, where roses and dahlias have been planted near poplars, the insects have shown a preference for the more ornamental plants.

The moths, which measure about an inch and a half in wing span, are of a dark purplish-grey colour, mingled with rust-red in the fore wings. The hind wings are brownish grey fringed with paler brown-grey. They appear on the wing in early spring. The yellowish-white eggs are laid on the poplars; from them emerge greenish larvæ, spotted with black and white, and marked longitudinally with three greenish-white stripes, a central broad stripe and two lateral narrower ones. From the trees on which the eggs are deposited, the larvæ descend to roses or dahlias in the vicinity and rapidly defoliate them.

The obvious remedy in this case would be to get rid of what may be called the parent trees, poplars, willows, and the like. It is equally obvious that this

method could hardly be put into operation. As a substitute, spraying with Paris green will be found effective.

The Garden Swift moth, *Hepiălus lupulinus*, L., is a very interesting visitant to flower gardens, on account of a curious habit possessed by the female. The reader who has scanned our pages thus far will have gathered that, in every case, the female deposits her eggs either on some plant which will supply food for her larvæ, or, at any rate, so close to a good food supply that the larvæ will have no difficulty in finding it. One hardly expects more parental solicitude than this among insects, though the earwig is said to mother its young, after the manner of a hen. The Garden Swift moth, however, appears to go to the other extreme, though she may be possessed of a sense, of which we are not aware, which renders her oviposition not quite the haphazard proceeding it appears.

The adults appear in late spring and continue on the wing well into the summer. They are rapid fliers and confine their activities to the twilight hours. In wing span they vary from an inch to an inch and a half. In colour they are still more variable. The fore wings are of a yellowish-brown shade, usually ornamented with a conspicuous, dark-edged, irregular white streak, which may be absent. The hind wings are a pale yellow-brown.

As the female flies rapidly hither and thither she drops her brown, earth-coloured eggs, apparently promiscuously, on the ground. The fact of ovipositing

during flight is in itself peculiar. Should no mishap befall the ova, they hatch in about ten days, and the larvæ at once pass into the ground in search of food. Of ornamental plants, they are particularly partial to pæonies; they also attack potatoes. As the damage is done to the roots, out of sight, the pest is particularly insidious. All through a mild winter, till the following spring, they continue their subterranean existence, feeding the while. By the following spring the larvæ are fully fed and measure about an inch and a half in length. They are cream-coloured and bear a characteristic dorsal V-shaped mark; their heads are brown. Pupation takes place in late spring, within a silken cocoon, which is spun below ground.

The best and cheapest remedy is to apply unslaked lime to the ground in early autumn.

Our excuse for mentioning the Brown China Marks moth, *Hydrocampa nymphæata*, L., is its extraordinarily interesting life-history rather than its great economic importance. As may be guessed from its scientific name, the insect is a pest of the white water-lily, *Nymphæa alba*, L. Water-lilies are found in comparatively few gardens, yet the lily pond is always the centre of attraction. Not only are the flowers themselves of surpassing beauty, but the leaves are decidedly ornamental as long as they remain undamaged. After a visit by the Brown China Marks moth, however, the lily pond presents a sorry sight. That a moth, at any period of its life-history, should possess aquatic habits appears to be an

anomaly, and in many respects *Hydrocampa* is anomalous.

These moths belong to the family *Pyralidæ*, and the genus includes several species with larvæ of aquatic habit. The adults measure approximately one inch in wing span. Their fore wings vary from orange-yellow to brown and are freely spotted with irregular white patches; the bases of the hind wings are white streaked irregularly with brown, and brown bands also run from margin to margin parallel to the distal edge.

Flying by night, as is usual, though not universal, among moths, the female settles upon the floating leaves of the white water-lily and deposits her eggs in clusters of from forty to one hundred, on their under sides, along the edge. Unprotected in such a position, the ova would fall an easy prey to various denizens of the water in which the lilies are growing, so a gelatinous substance is excreted by the mother moth, at the time of oviposition, to serve as a covering for the eggs. The larvæ emerge during the summer and feed upon the leaves, eating therefrom innumerable oval pieces, often approximately two square inches in area. The leaves are quickly reduced to ragged, unsightly remnants. Not only do the larvæ feed upon the leaves, but they carry portions of them to the upper surface and attach them securely thereto by silken threads. Sometimes they fasten two pieces of leaf together in the same manner. Whichever procedure be adopted, the object attained is the same—a case is formed in which the larva may hide and

continue its feeding unmolested. It will be remembered that the Larch leaf-miner, which also lives in a case in the larval stage, adds to its shelter when it proves too small; *Hydrocampa*, however, makes an entirely new case. When fully fed the larvæ measure about an inch in length and are cream-coloured, with very dark brown heads; the whole epidermis is studded with minute protuberances. At this stage the caterpillars, still in their cases, ascend some tall water-plant, to a spot well above water level, where they spin silken cocoons. After a short pupal stage of no longer than a fortnight, the adults appear. Collinge recommends the suspension of a lantern with a naked light over the lily pond. The night-flying moths will be destroyed in the flame.

Coleoptera

Beetles do not appear to be so troublesome in the flower garden as they are in the orchard and the forest. Nevertheless, there are one or two species which deserve mention on account of their interest or destructiveness.

The Green Rose Chafer, *Cetonia aurata*, Curtis, is one of our most beautiful British beetles, yet one of the insects most detested by rose-growers. In addition to roses, it attacks the leaves, blossoms, and roots of the raspberry, the roots of vines, the leaves of currants and beans, and the blossoms of pear, apple, privet, and turnip. The Rose Chafer belongs to the family *Cetoniidæ*, and vies in colouring with some

tropical species. The head, thorax, wing-cases, and legs are bright metallic green, tinged with gold. Though they vary considerably in size, they average about three-quarters of an inch in length. The adults appear in late spring and, on sunny days, may be seen busily flying from flower to flower, feeding voraciously and, of course, irretrievably damaging the blossoms. On dull, sunless days they are listless and never take to the wing, a fact of which advantage may be taken in exterminating them. From mid to late summer oviposition takes place, and the females, making free play with their fore legs, which are generously armed with short spines, burrow some distance below ground for the event. In a fortnight the larvæ emerge. They are repulsive-looking creatures (fig. 16), dirty white, with brown heads and legs and a brown spot on either side of the first segment. Their slightly hairy skin is considerably wrinkled and swollen at the tail end. They live underground and continue to feed on the roots of favoured plants for a period variously estimated at from two to three years. When fully fed they measure about an inch and a half long, though, owing to the fact that they are permanently curled up in the shape of the letter C, they appear somewhat smaller. Pupation takes place in an earthen cell formed of soil cemented together by their body secretions.

In dull weather, large numbers of the adults may be hand-picked and destroyed. The soil should also be forked over below the rose trees, and the larvæ either collected and destroyed or fed to poultry.

Theobald recommends the injection of carbon bisulphide as being the most effective remedy.

A beetle which is destructive to a very large number of garden plants, not only in the open but in pots, is the Clay-coloured weevil, sometimes called the Raspberry weevil, *Otiorrhynchus picipes*, F. The adults are about a quarter of an inch in length, oblong and clay-coloured. They are wingless, and spend the daytime on the ground, hidden beneath leaves, clumps of trees, etc., so that their colouring is protective, rendering their detection difficult, the more so as they have the typical weevil habit of remaining motionless when disturbed.

In late spring the adults appear and at once commence to damage garden plants of any and every description. Towards the end of summer the female deposits her eggs on the soil, and in a little more than a week the larvæ emerge. They are cream-coloured, with brown heads, rather hairy, wrinkled and legless. They are slightly curved, though not so markedly as the larvæ of the Rose Chafer. Throughout the winter they feed on the roots of various cultivated and wild plants, and pupate below ground in the spring.

Collinge, who has made a special study of this pest, suggests "placing overnight amongst the branches (of the plants attacked) bundles of loosely twisted hay made up into rope-like pieces. When removed in the morning, these were found to contain two or three dozen beetles. The bundles should be immediately burned on being removed." When these pests have

gained entrance into conservatories—as they will, on occasion—Collinge says: "Place a well-tarred wooden tray on the ground after dark, and while one person holds the plant over the tray, another provided with a lantern should smartly tap the stem, and the beetles will fall on to the tray. This operation carried out for a few nights will materially lessen the number of beetles. The plants should also be transferred to fresh soil some time between September and March. When this is being carried out, the roots should be carefully examined for the larvæ; the old soil should also be examined."

Diptera

We all know that certain human diseases are notifiable to the powers that be, and that failure to notify renders one liable to heavy penalties. It may not be generally known, however, that the Board of Agriculture has drawn up a schedule of pests and diseases whose presence must also be notified under penalty. Amongst this select band of evil-doers we find the name of the large Narcissus Bulb fly, *Merodon equestris*, F., a member of the family *Syrphidæ* or Hover flies. Whether this pest is a native of Britain or whether it has been introduced in bulbs from Holland is a debated point, and the matter is not very important from our point of view. It is of consequence, however, to know that the fly is a destructive pest of hyacinth, tulip, *Vallota*, *Galtonia*, narcissus, *Habranthus*, *Hippeastrum*, and daffodil.

The adults, which are about an inch long, are so variable that several varieties are recognised. In short, they vary from rich tawny to black with a grey tip to the abdomen. Whatever the colour, they closely resemble worker bumble-bees in general build, but are very much more active on the wing. The flies appear in the late spring and early summer, about the time when the foliage of bulbous plants is beginning to die off. They are not in evidence for long as imagos, and are usually only to be seen on sunny days, and then at the warmest hours of the day. At such times they may be seen sunning themselves on the leaves and darting from plant to plant with amazing rapidity, to the accompaniment of a characteristic buzzing. From time to time the females crawl amongst the dying foliage and deposit their eggs on the necks of the bulbs. The larvæ, which may be found from the summer till the following spring, feed within the bulbs, reducing them to a state of decay. Should the bulb in which the larvæ are hatched provide no further nutriment, migration takes place to undamaged bulbs, either growing or stored, entrance being gained by boring through the base or side. When fully fed the dirty white-coloured larvæ measure rather more than half an inch in length; during the whole of this period they are exceedingly sluggish. Pupation takes place within the bulbs, in a puparium formed from the larval skin.

When the adults are noticed in the vicinity of bulbs, large numbers may be netted, and their numbers

may be much reduced in this manner. Suspected bulbs should never be planted, though it must be admitted that it is impossible to detect the early stages of an attack, the first apparent symptoms being a softening of the necks of the bulbs. In cases of a bad attack all the bulbs should be taken up and burned and the top soil deeply buried; early autumn is the proper season for this operation.

Another dipterous bulb pest, not as yet so widely distributed in Britain as *Merodon*, is the small Narcissus Bulb fly, *Eumerus strigatus*, Fallen. These little flies appear to mimic bees of the genus *Halictus*, for some unknown reason. They are about a quarter of an inch in length and of a shiny, metallic black colour; the thorax is ornamented with some long tawny hairs, and the abdomen with short grey ones. The life-history is imperfectly understood, but probably is nearly identical with that of *Merodon*, and the same precautions should be taken in dealing with the pest.

The Holly leaf-miner, *Chromatomyia ilicis*, Curt., is a fly of the family *Phytomyzidæ*; moreover, it is exceedingly common, for practically every holly bush will reveal some specimens. The eggs are laid in June on the under sides of the leaves, one on each midrib near the leaf-stalk. In a week the larvæ, which are white and legless, emerge and, boring into the tissues of the midrib, travel towards the apex. About three months later, the midribs are forsaken for the softer tissues of the leaves and the characteristic blisters are formed. By April the larvæ are

mature, and after biting through the epidermis of the leaf, to make an exit for the adults, pupation takes place. Shortly afterwards the adults are on the wing.

The leaf-miners closely resemble minute horse-flies; about one-eighth of an inch from tip to tip of the wing, they have chocolate-coloured eyes, black-veined, hyaline wings, and black, hairy bodies, narrowly banded with white above, and often pale yellow below.

As damage is done, for the most part, to the leading shoots, it is advisable to burn all autumn and winter prunings. Spraying with weak paraffin at about the time of oviposition also has the effect of deterring the females from laying their eggs on the leaves so treated.

An allied species, *Chromatomyia obscurella*, Fln., mines the leaves of snowberry, *Symphoricarpus racemosus*.

Other Diptera which are unwelcome visitors to the flower garden are the Carnation fly, *Hylemyia nigrescens*, Rud.; the Chrysanthemum fly, *Napomyza lateralis*, Fall.; the Common Crane fly, *Tipula oleracea*, L., dealt with in another chapter; and the Spotted Crane fly, *Pachyrhina maculosa*, Meign. The habits and life-history of the last-named pest are so similar to those of the Common Crane fly that they need not be discussed. In the flower garden, the larvæ damage the underground parts of various ornamental plants, including tulips, dahlias, lilacs, and carnations; they also attack lettuces, potatoes, strawberries, and raspberries.

The Carnation fly deposits her eggs on the foliage of pinks and carnations. The minute larvæ, immediately they are hatched, make their way to the stems, where they tunnel in the pith. Pupation takes place in the stem. The Chrysanthemum fly deposits her eggs in the leaf-tissues of marguerites and chrysanthemums. The larvæ make sinuous tunnels in the mesophyll, which renders the leaves unsightly; pupation takes place in the tunnels. Attacked leaves should be picked and burned, whilst in severe attacks by both these flies the plants should be destroyed.

Hymenoptera

The hymenopterous pests of the flower garden are not very numerous. Bees of the genus *Megachile* are annoying, though hardly important pests. They are known as Leaf-cutter bees, owing to the peculiar habit they have of cutting almost geometrically accurate circular pieces from the rose foliage. These pieces they use to line their nests, which are made in decayed wood, among other places.

A more important pest of this order is the Wood-boring Rose Sawfly, *Emphytus cinctus*, L. The adults are about half an inch in length and shiny black in colour, with transparent wings, the fore edge of which is brown. On the thorax are two round pale-yellow spots; the first abdominal segment has a pale mark, and, in the female, there is a pale band in the fifth segment which is absent in the male.

The adults appear in early summer, and the female

deposits her eggs in slits, as is usual among the Sawflies, on the under sides of the rose leaves. In about a month the pale-green larvæ appear and feed on the rose leaves, which they quickly eat down to the veins. When at rest they lie curled up on the under sides of the leaves. When they have devoured all the foliage they make their way into the stems, often by way of a pruned end, and tunnel in the pith, where they remain in the larval stage throughout the winter. Pupation takes place in the early spring. There appear to be two broods in a season, for larvæ may be discovered feeding on the foliage in early autumn.

Spraying with tobacco water will kill the larvæ on the foliage. When the stems are attacked they should be cut back beyond the damaged area, and the prunings should be burned.

Rhynchota

The greenhouse is an important adjunct to every garden, either as a forcing house for young stock or for the culture of plants which will not flourish in our variable climate. Before passing from the flower to the vegetable garden, let us therefore consider one or two of the many insect pests which thrive under glass.

Common and annoying pests are the two species of Mealy bug, *Dactylopius longispinus*, Targ.-Tozz., and *D. citri*, Risso. The latter is the commoner species, so an account of its life-history may serve for both. Mealy bugs, so called on account of the mealy wax with which the females are covered, belong to the

family *Coccidæ*, a family which includes a far larger proportion of harmful insects than any other.

The adult female is very minute, about one-tenth of an inch in length, of a pinkish white, mealy appearance, ovoid in outline, studded round its margin with short blunt spines of equal length except two at the head, which are considerably larger than the others. The male, unlike the female, is winged and is also mealy. Its transparent wings are beautifully iridescent. The life-history is simple, and reproduction continues all the year round, under glass. Practically all hothouse plants are liable to attack, but Mealy bugs show a preference for vine, stephanotis, hoya, bouvardia, ageratum, gardenia, camellia, and asparagus fern. The eggs are laid by the females on the food plants, and are peculiar in that they are covered with a dense white tuft of thread-like processes. The larvæ and adults damage the plants by piercing the tissues and abstracting the juices. On certain plants, attacks by Mealy bug are followed by the growth of a dense black fungus which thrives on the secretions of the insects.

Various devices have been used to clear plant-houses of these pests. Fumigation with hydrocyanic acid gas is strongly advocated in some quarters, but it is often harmful to the plants. The old-fashioned, though tedious, remedy of carefully going over the plants, one by one, and dabbing the Mealy bugs with a brush, charged with methylated spirit, is still the safest and best.

A Mealy bug with subterranean habits is by no

means rare. This insect, *Ripersia terrestris*, Newst., is probably an introduced species. It appears to be nearly as catholic in its tastes as *Dactylopius*, for it has been recorded as attacking various palms and ferns, especially maidenhair, hyacinths, and stephanotis. The insects attack the roots of the plants, with the result that the leaves rapidly turn brown and finally the plant dies.

The females are quite as mealy as *Dactylopius*, but are more elongate in outline. They secrete clusters of white waxy threads on the roots, and in these clusters they live and deposit their eggs, which are also mealy.

The larvæ very closely resemble the mother bugs, and under favourable conditions they reach the adult stage very rapidly.

When this pest makes its appearance the plants should be turned out of their pots, all the soil should be removed and burned, and the roots washed in two lots of clean water. The pots themselves should be scalded before the plants are re-potted. This operation should not be performed in the vicinity of healthy plants, as there is a risk of the insects, or their eggs, being carried to them by air-currents.

Closely related to the Mealy bugs are the Snow-flies, *Aleurodidæ*, of which there are several species in this country. One is a pest of cabbages, another an enemy of the oak, a third and rarer species attacks strawberries, whilst *Aleurodes vaporariorum*, Westw., is a common greenhouse pest. They are called Snow-flies because infested plants, when shaken, give off a

cloud of the white insects, which appear like fine snow. The adults, which are sometimes mistaken by the unentomological for minute moths, are exceedingly delicate and measure but one-eighth of an inch in wing span. Fumigation with tobacco will remove this pest from the glass house.

CHAPTER V

PESTS OF THE VEGETABLE GARDEN

In the following pages we shall devote a little space to the consideration of some typical insect enemies of vegetables. Again we are confronted with the difficulty of establishing a rigid barrier 'twixt pests of the kitchen garden and those of farm crops, for it is clear that the same insects which devastate a single row of peas will lay waste identical plants when they spread over several acres.

Lepidoptera

It is always a rash proceeding to generalise, but it may safely be stated that the butterflies are the most harmless of all insects. Few of them, the world over, can be classed as pests. In this country, however, we possess two of these insects which at times cause considerable damage; they are the Large and Small Cabbage White butterflies, *Pieris brassicæ*, L., and *P. rapæ*, L. (fig. 17). Except for a difference in size, the Cabbage Whites are similar in appearance and habits, so a consideration of the life-history of the larger species will suffice. Crucifers of all kinds are readily devoured by the larvæ, but cabbages appear to be the most favoured food plants.

A description of these well-known insects is hardly necessary. White, with black-tipped fore wings and a black spot on the anterior margin of the hind wing, the males may be distinguished from the females by the fact that the former have one black spot on the fore wing, whereas the latter have two. The females, which are active in the spring, deposit their yellowish-green, elongated eggs on the under sides of the leaves of the food plants. In less than a week the larvæ emerge. Those of *brassicæ* are of a dull-green shade spotted with black; when fully fed they turn lighter green or even yellowish. The larvæ of *rapæ* are green, with a single median, dorsal, yellow stripe and a row of yellow spots on either side. In both species the larvæ are fully fed in about a month, when they betake themselves to fences, walls, etc., in order to pupate.

All plants on which the larvæ are observed should be dusted with finely powdered lime. Many of the larvæ are washed from their food plants and destroyed during heavy rain; a like result may be brought about artificially by subjecting the plants to a forcible spray of plain water.

Another troublesome pest of Crucifers is the Diamond-backed moth, *Plutella maculipennis*, Curtis, a member of the family *Tineidæ*. This little moth bears a close superficial resemblance to a clothes moth, especially while at rest, when its fore wings are kept closely pressed together. In the resting position, the two posterior margins, which are adjacent to one another, are marked with yellow,

17. SMALL CABBAGE WHITE BUTTERFLIES, *Pieris rapae*, L.
a. LARVA; *b*. PUPA; *c*. MALE; *d*. FEMALE

wavy patches, together forming a row of diamond-shaped areas from which the insect derives its popular name. The anterior portions of the fore wings are bronzy brown. From head to folded wing-tip, the moth measures one quarter of an inch.

The female deposits her minute, whitish eggs on the leaves of turnips, cabbages, etc. From these arise pale-green, spindle-shaped larvæ, which attain a length of about half an inch when fully fed. Pupation takes place on the dead stalks of the food plant or on neighbouring rubbish, in a delicate silken cocoon, through the walls of which the contained pupa is plainly visible.

Wet weather is harmful to the larvæ of the Diamond-backed moth, and the water spray recommended above may be used with advantage. A lime and soot dressing, one part of the former to three parts of the latter, is also effective.

Coleoptera

A conspicuously marked beetle pest of the vegetable garden, and one whose eggs are discovered without difficulty, which nevertheless continues to thrive, despite the fact that it apparently has but one food plant, is the Asparagus beetle, *Crioceris asparagi*, L. (fig. 18). The family *Criocerida*, to which this beetle belongs, is closely related to the *Chrysomelidæ*, which contains several destructive species. Amongst them may be mentioned the Colorado Potato beetle, *Leptinotarsa decemlineata*, Say, which at one time proved an inveterate enemy of the Irish potato in America, and

produced something akin to panic when it appeared in Essex a few years ago.

The adults are about a quarter of an inch in length and are variable in colour. The head is blue-black, thorax red, wing-cases yellow, with a broad median blue-black band and a broad transverse band of the same colour. The females deposit their eggs in June on the heads and shoots of the asparagus; later in the season oviposition takes place upon the foliage. The brown eggs are spindle-shaped and about a sixteenth of an inch long, and they may be deposited either singly or in rows of from two to seven. The female deposits her eggs as she ascends the shoots and, in consequence, they are in line with one another. The larvæ hatch in less than a week and at once begin to feed upon the shoots; the later larvæ feed on the foliage. They are fully fed in about a fortnight and then measure a third of an inch or so in length. In colour these larvæ are variable, shades of green and grey predominating; fat, fleshy, and wrinkled, with black heads and legs, they are as repulsive-looking as the adults are beautiful. Pupation takes place in the soil, within a round earthen cocoon, and lasts but a fortnight or three weeks. There are usually two and sometimes three generations a year, and the winter is passed in the adult stage.

Refuse under which the adults might hibernate should be destroyed. The larvæ may be eradicated by spraying with paraffin emulsion or by dusting the plants with finely powdered lime while the dew is on them. After the asparagus has been cut, but not

FIG. 18.
ASPARAGUS BEETLE,
Crioceris asparagi, L

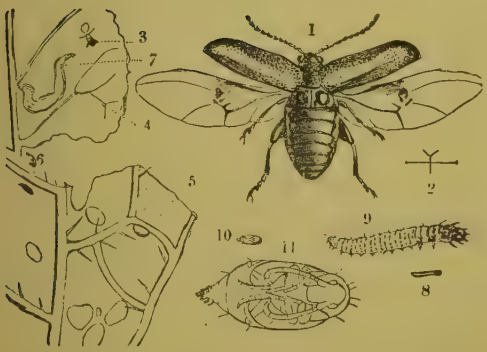


FIG. 19. TURNIP FLEA BEETLE, *Phyllotreta nemorum*, L. 1. ADULT MAGNIFIED; 7. TUNNEL IN LEAF MADE BY THE LARVA; 9. LARVA MAGNIFIED; 11. PUPA MAGNIFIED

before, spraying with arsenate of lead is an effective remedy.

The Turnip Gall weevil, *Ceutorrhynchus sulcicollis*, Gyll., is a diminutive beetle, one-eighth of an inch long in the adult state, belonging to the family of Snout beetles, *Curculionidæ*. Regarded by many as a harmless nuisance rather than a pest of any account, it is, in fact, responsible for a considerable amount of damage to our native turnip and swede crops. To a minor extent this beetle attacks cabbage, kohl-rabi, sprouts, savoy, thousand-headed kale, mustard, rape, charlock and other cruciferous weeds.

The adults make their appearance in the spring and early summer; they are almost black in colour, with a slight pubescence on the back, which becomes more dense ventrally. The thorax is dotted with minute pits, and they are also found on the wing-cases, between the longitudinal grooves which traverse these organs from base to apex. Their food consists of nectar derived from the flowers of various Cruciferæ—plants of the turnip family. The females pass into the ground when they are ready for egg-laying, and, boring holes in the roots of the plants, they deposit a single egg in each hole. If the attack be made on a well-grown plant, the damage may amount to little more than a few unsightly swellings. Should a young plant, however, be selected as the home of the larvæ, growth may be retarded to such an extent as to render the plant valueless.

The larva emerges within the cavity in which the egg was laid. When first hatched it is exceedingly

minute, pearly white, with a brown head, curved and legless. It feeds within its vegetable chamber, and in so doing causes a swelling to appear, at first no larger than a pin's head, but by degrees increasing to the size of a hazel nut or even larger. By cutting open one of these galls the young larvæ may be found in a central hollow chamber. After a period which is very variable, ranging from one to three months, the larva is ready to pupate and measures about a quarter of an inch in length. At this stage a hole is eaten in the gall and the larva passes into the soil, where it forms for itself an earthen cocoon composed of a mixture of saliva and fine soil particles. Within the cocoon pupation takes place and, in the summer, the adult beetle emerges in a fortnight. The length of the life-cycle varies according to the season; in summer it may be completed in seven weeks, in the winter and spring it may extend over as many months.

In gardens, dibbling in each plant with lime or soot is a useful preventive, whilst, after an attack, deep trenching is the best remedy. A dressing of soot on turnip and swede crops, after the seed has sprouted, is also recommended to ward off the attacks of the female beetles. All infested cabbage stalks should be burned, so that the larvæ may not escape into the ground. In the case of more extensive crops which are attacked by the weevil, deep ploughing followed by rolling should be resorted to, and crop rotation is, of course, an obvious proceeding.

Other weevil pests of the vegetable garden are

the Striped Pea weevil, *Sitŏnes lineatus*, L., and the Spotted Pea and Bean weevil, *Sitŏnes crinitus*, Herbst. Unlike many crop pests, they do damage both in the adult and larval stages. The adults devour the leaves of peas and broad beans, whilst the larvæ confine their attacks to the roots. The Striped Pea weevil is the commoner and more destructive species. After hibernating in the adult stage, it becomes active in early spring. Measuring about a quarter of an inch in length, in general colour it is greyish. The thorax is marked dorsally by four darker lines, as also are the elytra (wing-covers), though in the latter case the lines are usually inconspicuous. Ventrally, they are of a uniform brownish grey. During June the females deposit their eggs on or just below the soil. When the larvæ emerge they bury themselves in the soil and feed on the roots of beans and peas and occasionally on other plants, such as lettuce. The larvæ are creamy white, footless grubs, within earthen cells, and from them a second brood arises which confines its attention to clovers and allied plants. The eggs of this second brood are deposited on the clover roots, and the larvæ arising therefrom subsist on the roots during the winter, causing the clover to die off in patches. The adults appear in May and June, and are brighter-coloured than the weevils which have hibernated in the adult state. The adults are shy and at the least shock fall to earth, where they lie motionless, feigning death for several minutes, with their legs drawn close to their bodies.

On account of this habit they frequently escape notice, and the damage that they do is attributed to sparrows, though these birds leave a jagged edge to the leaves they have damaged, whereas the beetles eat out regular semicircular pieces. The leaves of young plants only are damaged.

As the beetles do most damage where the soil is rough, rolling with a light roller followed by a heavy dusting with soot is a good remedy. In gardens, fine soil should be sprinkled over the rows of peas and beans to keep the beetles away, or, as an alternative, a spray of paraffin emulsion should be used.

Among the worst enemies of the farmer and gardener in Britain are the flea beetles (fig. 19) of the family *Halticidæ*, so called because they jump, after the manner of fleas. They are widely spread; over one thousand six hundred species are known, and of these, one hundred and twenty species occur in Britain. At least ten British species are injurious, but we have only space to deal with two of them in this chapter. The Turnip flea, Turnip fly, or Striped flea beetle, *Phyllotrēta nemorum*, L., and the Cabbage flea or Black Jack, *Haltica oleracea*, L., are the most destructive. The Potato flea, *Phyllotrēta affinis*, Payk., is at times a pest of potatoes, but rarely attains serious proportions; it also attacks artichokes and rhubarb, and is said to subsist on the leaves of bitter-sweet, *Solanum dulcamera*, when it is unable to find other food plants.

Although *Phyllotrēta nemorum* is known as the

Turnip flea beetle, it does not confine its attentions to this useful plant nor even to plants of the same order. In addition to cabbages and uncultivated cruciferous plants, it attacks nasturtiums, rhubarb, hops, and horse-radish. The beetles may be found at any season of the year, for they hibernate as adults and are active from early spring till November. Atmospheric conditions have a marked effect upon flea beetles; they hate wet weather, and the brighter the day the more rapidly they multiply and the more voracious they become. In the first bright days of spring the adults leave their winter quarters and begin their work of destruction. On this point Theobald, speaking of British flea beetles in general, says: "In 1786 Mr Young estimated that the loss in Devonshire alone by the flea beetle was £100,000, the entire crop being destroyed. Again, in 1881, some estimate of the loss caused to roots was gathered. It was calculated that the loss for seed, expenses of sowing and re-sowing in twenty-two English and eleven Scotch counties amounted to over £550,000, independent of other losses due to the failure of the crop. This loss affected the price of store sheep and lambs, reducing the value from 5s. to 10s. each. In many cases buying ceased altogether, owing to the shortness of keep."

The adults are about one-eighth of an inch in length and oval in form, of a blackish colour, with the exception of each wing-case, which bears a longitudinal yellow stripe. The first food consists of cruciferous weeds such as shepherd's purse, whitlow grass,

charlock, and jack-by-the-hedge, and on these the adults feed till the leaves become coarse, when they migrate to cultivated plants, turnip and cabbage by preference. When these plants in turn become more coarse, another exodus is made to the weed plants, on which the beetles continue to feed till they die down in autumn, and beneath the dead leaves they hibernate. Seedling leaves they eat entirely; older leaves are devoured in such a manner that only the mid and secondary ribs remain untouched. Feeding never takes place, even in the warmest weather, till the dew is off the leaves. The minute, oval, greyish eggs are laid in clumps on the under side of the leaf of some food plant, usually near a rib. Each female is said to lay about eighty eggs. In scarcely more than a week the larvæ appear; at first they are white, with brown heads, but later they turn dull yellow. They immediately tunnel into the soft tissues of the leaf, and the damage they do is not easily seen at this stage, but in a short time their burrows turn brown and are then easily distinguished. In about ten days the larvæ attain a length of rather more than an eighth of an inch and are mature; they eat their way out of the leaf and pupate either below the soil or occasionally on the leaf. The lapse of a fortnight sees the advent of the adult beetles, so that the whole life-cycle is completed in a month or rather less. The number of broods in a year is a debated point; much, no doubt, depends on the weather conditions. In a dry summer there are probably six, and in less favourable seasons three or four.

They sometimes increase to an alarming extent, and, according to a reliable authority, no less than twenty-four thousand nine hundred and sixty specimens have been captured in five minutes in an ordinary entomological net.

As a preventive of these beetles, all cruciferous weeds on which they may feed and beneath which they may hibernate should be destroyed. Earth, impregnated with paraffin, scattered over the beds will keep *nemorum* away, for all flea beetles have a very keen sense of smell. Strewing hay on the ground in the vicinity of the beetles, in autumn, before they have retired to their winter quarters, forms a useful trap. The hay, together with the hibernating beetles, may be burned later.

The Cabbage flea beetle is rather less than three-sixteenths of an inch in length, and of a bright, metallic blue-green colour. In many respects it resembles the Turnip flea in habits and life-history. It is not quite so susceptible to atmospheric changes as its relative; it attacks old and young leaves indiscriminately; the adult eats away the upper skin and the mesophyll, leaving the lower skin; the Turnip flea beetle perforates the leaves. The larva feeds on the leaf instead of in it; pupation takes place in the ground. There are five or six broods in a year. In addition to cabbages, *Haltica oleracea* feeds upon turnip, charlock, nasturtium, willow herb, and evening primrose.

In addition to the suggestions made for dealing with *nemorum*, the larvæ of *oleracea* may be effectively

eradicated by spraying with Paris green. We have mentioned the Cabbage flea beetle, as well as its near relative the Turnip flea beetle, with a dual purpose: to emphasise the importance of accurate determination of injurious insects, and also to show that species with habits in many respects similar, may exhibit such differences as to necessitate dissimilar treatment. We have said that, in one case, the larvæ feed within the leaves of the food plant, in the other they feed on them. Insects hiding within the leaf-tissues cannot be eradicated by any spray which will, at the same time, be harmless to the plants. When they dwell on the outsides of the leaves the case is different. From this it is clear that, before treatment is attempted, either the insect must be correctly identified and its habits learned from a reliable authority, or its life-history must be worked out by personal observation. To deal with every species of flea beetle in the same manner will only lead to disappointment, a remark which in many cases applies to other insects closely related to one another.

Wherever crops or ornamental plants are grown, in the field, the garden, or the glass house, Plant Lice or Aphidæ are liable to put in an appearance. These insects are often termed Green-fly, though the name is a misnomer, for many species are by no means green. We have at least two hundred species of Aphis in Britain, and it is obvious that we can only deal with a minority in these pages. One of the most destructive species likely to occur in the vegetable garden is the Bean Aphis, *Aphis rumicis*, L., also known as the

Collier and Black Blight. Its food plants are varied and dissimilar; of cultivated plants it prefers the broad bean, but it will also attack other leguminous garden plants and, in addition, rhubarb, marigolds, salsify, nasturtium, ivy, holly, and borage. Weeds in the shape of teazle, polygonum, foxglove, gorse, curled dock, *Rumex crispus*, broad dock, *R. obtusifolius*, red-veined dock, *R. sanguineus*, spear thistle, *Cnicus lanceolatus*, marsh thistle, *C. palustris*, creeping thistle, *C. arvensis*, and meadow thistle, *C. pratensis*, are also favoured food plants; in fact, the docks and thistles are prime favourites.

These Aphides cause a twofold damage to the plants. By embedding their awl-like beaks into the plant tissues and imbibing the juices they induce a lessened vitality. Greater damage, however, probably ensues from the large quantity of sticky honey-dew which they excrete. By it, the breathing pores of the leaves are choked up and respiration is retarded or stopped entirely. The life-history is complicated, and is rendered more so on account of the numerous food plants and the constant migrations of the insects from one to the other. The females may be either viviparous or oviparous, that is to say, they may produce living young or they may deposit eggs from which immature insects will arise. The oviparous Colliers are wingless, the viviparous forms may be winged or wingless.

In the spring, wingless viviparous females arise from the eggs which have survived the winter. They are black in colour, with the exception of some yellow

marks on antennæ and legs. They vary considerably, some being of a lustrous black, others are velvety black, others again appear to be covered with a grey powder. Young are produced by the viviparous females in extraordinary numbers; at first they are all dull grey, but they soon assume the colouring of the adults. The heads of the food plants rapidly become crowded with Colliers, and some or all of the colony change into pupæ with black abdomens and wing-cases and grey heads and thoraces. The pupæ give rise to lustrous black, winged, viviparous females; with the aid of their short, iridescent wings they fly to other beans, to docks or thistles. On their new-found plants they produce living young throughout the summer. Towards autumn there is a general migration to docks and gorse, and on these plants a sexual brood is produced consisting of wingless oviparous females and winged males. The former deposit their eggs near the bases of the modified gorse leaves or on the stems of docks, near the ground. The winter is passed in the egg stage.

In the vegetable garden, topping the infested plants is by far the best remedy. Where a larger crop is grown, two heavy sprayings with soft soap and quassia will prove efficacious.

Diptera

The most important pest of the onion is undoubtedly the Onion fly, *Phorbia ceparum*, Bouché (fig. 20). The insect belongs to the family *Anthomyiidæ* and superficially resembles a very small house-fly. The male is

about three-eighths of an inch in wing span, grey in colour, with three black longitudinal stripes on the thorax and a central row of black spots on the dorsal surface of the abdomen. The female is rather larger than the male and of a yellowish rather than a grey colour.

The adults appear in the spring, about the time when the young onions begin to show. The female deposits from two to six of her white oval eggs in the leaf-axils of each plant. The larvæ appear in a few days and pass down the leaf-sheath to the bulb, where they feed for a fortnight or rather longer, passing to undamaged bulbs should the ones first attacked become decayed before they are fully fed. When ready for pupation the legless larvæ are about three-eighths of an inch long, segmented, cream-coloured, with black, hooked mouth parts at their anterior extremities, whilst posteriorly they terminate obliquely. The margin of the posterior segment is studded with tubercles. The onion bulbs are forsaken in favour of the soil prior to pupation; the larval skin shrinks and hardens, forming a puparium, from which the flies emerge in a fortnight and attack previously undamaged onions. There are three to four broods in a season, and winter is passed in the pupal stage—at least that is our personal experience, though Pettit states that some of the adults hibernate through the winter.

This pest is a most difficult one to deal with; there is practically no remedy, but some good may be done by the application of fertilisers which will encourage rapid growth. After an onion bed has been attacked there

should be a rotation of crops, and the ground should be deeply trenched and dressed with a soil insecticide.

Of the two common dipterous pests of celery, the leaf-miner, *Acidia heraclei*, L. (fig. 21), and the stem-fly, *Prŏphila apii*, Westw., the former is the commoner and more injurious. The Celery leaf-miner, often called the Celery fly, is a handsome insect of a general yellowish-brown colour, with beautiful green eyes. The legs are yellow, and the wings, which span rather less than half an inch in the male and rather more in the female, are iridescent and marked with brown blotches; at rest, they are folded vertically. Both celery and parsnips are attacked by this insect.

The adults are on the wing in the spring, and the female lays a large number of eggs on the upper surface of the leaves of the food plant. In about a week the larvæ emerge, and, without delay, tunnel into the leaf-tissues, forming sinuous passages, by eating away the mesophyll between the upper and lower skins. In a fortnight the greenish-white, legless larvæ are fully fed and change into puparia either within the leaf or, more usually, in the ground. The puparium is a barrel-shaped, straw-coloured structure one-eighth of an inch in length and covered externally by the shrunken, hardened larval skin. The pupal stage is of short duration, a few days at the most. There are several broods in a season, and the final brood passes the winter in the pupal stage. In severe attacks the plants may be killed. In milder attacks the results may be equally disastrous, from an economic point of view. The plants being

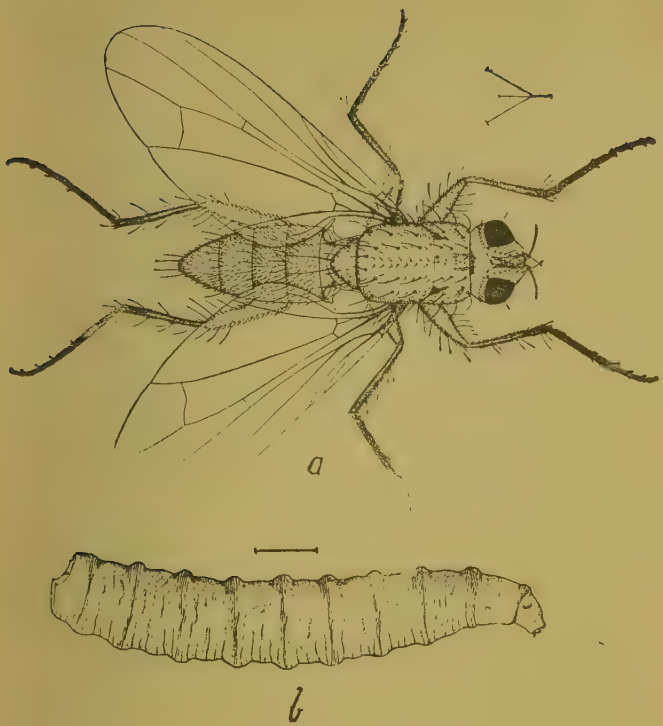


FIG. 20. ONION FLY, *Phorbia ceparum*, BOUCHÉ.
a. ADULT; *b*. LARVA

FIG. 21. CELERY LEAF MINER, *Acidia heraclei*, L.
1. ADULT; 2. LARVA; 3. PUPARIUM

deprived of their assimilatory organs, the leaves, owing to the insect damage, are unable to elaborate the food material necessary to fill out the fleshy parts of their stems.

By freely dusting the plants with a mixture of soot and lime while the dew is still upon them, the flies may be prevented from ovipositing. The same end may be attained by spraying with carbolic acid and soft soap. After an attack, the beds should be well dug and treated with gas-lime, to kill all the puparia which may remain in the soil; all the remains of the plants should be burned.

The Celery stem-fly, or rather its larvæ, are the cause of the rust-coloured tunnels often observed in the stems. The adults appear in late spring and, as yet, their mode of living has not been accurately determined. The treatment, however, recommended for the leaf-miner may be used with advantage in this case.

Another fly, all too common in the vegetable garden, is the Carrot Rust fly, *Psilâ rosæ*, F. (fig. 22), which is so named because the spots damaged by the larvæ turn a rusty brown colour before they decay. The first indication of an attack by this pest is the change in colour of the foliage leaves, from a healthy green to a sickly yellow. As the attacks are always more pronounced in dry weather, the failing of the leaves may erroneously and excusably be attributed to lack of moisture. The adults are very dark metallic green in colour, and measure approximately half an inch in wing span. The head is orange, the legs yellow, and

the veins of the iridescent wings are yellow. The flies appear in the spring, and the females do not deposit their eggs upon the foliage, after the manner of the Celery stem-fly and some others, but go below the surface of the soil and oviposit upon the young roots. The yellowish, legless larvæ bore into the roots and tunnel hither and thither, keeping near the exterior in their younger stages. From time to time, in fact, they make tunnels through the outer tissues of the carrot, so that, when an infested root is pulled, several of the larvæ may be seen partially protruding. The fully fed larva is about a quarter of an inch long; at this stage the carrot is forsaken for the soil, where pupation takes place. The mahogany-coloured puparium is cigar-shaped and bears a pair of black spots on the blunter end. There are several generations in a season, and the last one passes the winter in the pupal stage.

As the females must pass below the surface of the soil to oviposit, precautions should be taken to prevent them from doing so. This may be brought about by heavy watering or by pressing the soil closely round the roots. The application of dilute paraffin emulsion at intervals, from sowing time till after thinning, is effective, as also is the spreading of sand, soaked in paraffin, among the newly thinned plants. After an attack, the land should be dressed with gas lime.

THYSANOPTERA (fringe wings)

Although the *Thysanoptera* have not been studied so deeply as have the majority of orders of insects,

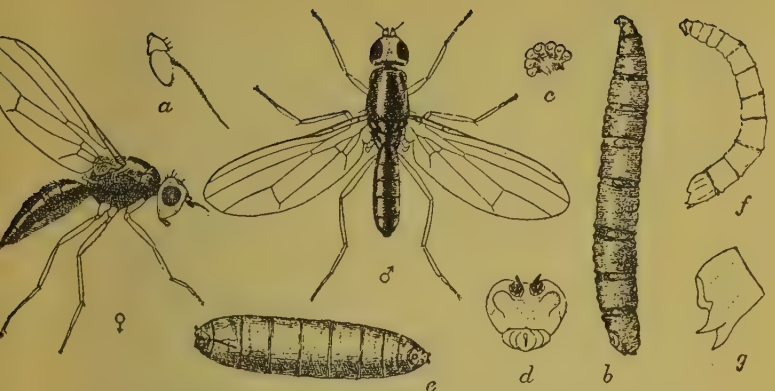


FIG. 22. CARROT RUST FLY, *Psila rosae*, F. *a.* ANTENNA OF MALE; *b.* FULL-GROWN AND YOUNG LARVA; *c.* LARVAL SPIRACLES; *d and g.* POSTERIOR SEGMENT END AND SIDE VIEWS; *e.* PUPARIUM

FIG. 23. YELLOW UNDERWING MOTH.
Triphaena pronuba, L

CHAPTER VI

INSECT ENEMIES OF FARM CROPS

We in Britain, fortunately, are not able to record any pests which decimate our crops over large areas, bringing ruin in their wake. Two factors are responsible for this satisfactory state of affairs. Our climate, in the main, is not conducive to teeming insect life, and the acreage covered by our most extensive crops is a mere trifle, compared with the areas under cultivation with crops of one kind in America, Australia, etc. In another volume (*Insects and Man*) we dealt with some of these larger problems. We told what severe blows were dealt to the American cotton industry by a small weevil, *Anthonomus grandis*, Boh.; we related the story of the devastating Gipsy moth, *Porthetria dispar*, L., and of the waxing and waning of the San José Scale, *Aspidiōtus perniciosus*, Comst., in the same country. Though our troubles are less, they are sufficiently disastrous, at times, to merit the closest attention, from farmers and scientists alike. Many of these troubles could be prevented with a little care; most could be mitigated if those responsible would realise that our insect enemies must be dealt with ruthlessly and not permitted to increase till

they get out of hand. We are apt to despise the well-worn maxims of the copy-book. In our dealings with insects, however, we may profitably bear in mind the virtues of the timely stitch and that there is something better than cure.

Lepidoptera

The larvæ of three of the most destructive moths to every kind of crop, whether on the farm or in the vegetable and flower garden, are known collectively as surface caterpillars. The moths, whose larvæ have gained this unenviable reputation, are the Great Yellow Underwing, *Triphæna pronuba*, L. (fig. 23), the Heart and Dart moth, *Agrōtis exclamationis*, L. (fig. 24), and the Turnip Dart moth, *Agrōtis segetum*, Schiff. All three are members of the family *Noctuidæ*. The favourite food plants of these insects are turnips, swedes, mangolds, and potatoes; they also attack radishes, lettuces, cabbages, parsnips, onions, beans, beet, carrots, wheat, grasses, various ornamental plants and seedling trees. As one entomologist remarked, it would be easier to detail the plants which are free from their attacks.

The fore wings of the Yellow Underwing are very like those of the Turnip Dart moth and span rather more than an inch and a half. The hind wings are yellow with a band of dark brown along the edge.

The female Heart and Dart moth measures about an inch and a half in wing span. Her fore wings are of a rusty brown colour and the hind wings

paler and of a more grey-brown shade. The male is rather smaller and lighter in colour; his hind wings are often cream-coloured or nearly white. The Turnip Dart moth is of approximately the same size as the Heart and Dart moth, and the female has dark brown fore wings, with very pale hind wings edged with brown. The male has grey-brown fore wings and lustrous white hind wings.

The habits of all three species are so similar that they may be described together. The adults appear in the summer, and the females deposit their relatively small eggs on the selected food plant, which may be wild—plantain, chickweed, and Crucifers are favourites—or cultivated. A point close to the ground is always selected; in fact, the Turnip Dart moth sometimes oviposits on the ground itself. The larvæ hatch in about a fortnight and at once begin to feed on the vegetation in the vicinity. It is not easy for anyone but an expert to distinguish the species in this stage. They are all very similar to the soil in general colour; the caterpillars of *exclamationis* being rather darker than those of *segetum*, whilst those of *pronuba* may be distinguished by their paler colour and a light, median, dorsal stripe.

All three species feed by night, hiding by day beneath the soil or under leaves, etc., a habit which has earned them their name of surface caterpillars. Abroad, they and some allied species are known as cutworms, from their propensity for cutting off the young shoots, level with the ground. Feeding continues from the time the larvæ emerge, right through

the autumn till winter, when they usually retire into the ground and form earthen cells in which to hibernate. In mild weather, they continue their activities throughout the winter. In the spring the larvæ become more active, their appetites attain alarming proportions, and they eagerly attack every available morsel of green food till they are fully fed. At this stage they measure about an inch and a half in length. Pupation takes place in the ground and the adults appear about a month later.

Noxious as these pests are, few efficient remedies have been discovered. The old and tedious method of hand-picking still remains one of the best; the work should be carried out at night with the help of a lamp, when the larvæ are feeding. Collinge recommends the application of naphthalene and lime as being "the best remedy we have yet for this and allied pests."

Two other members of the family *Noctuidæ* have somewhat different habits, nevertheless they are pests of importance. One, the Cabbage moth, *Mamestra brassicæ*, L. (fig. 25), attacks Crucifers of all kinds, with a preference for cabbage, also lettuce and dahlias. The other, the Dot moth, *Mamestra persicariæ*, L., in addition to crops of the farm and kitchen garden, attacks raspberry, gooseberry, currant, apple, and plum trees. The larvæ have also been taken on ivy, lilac, poplar, clematis, dahlia, marigold, marguerite, geum, and pansy.

The fore wings of the Dot moth span an inch and a half; they are very dark brown, almost black,

in colour, with a dark purple sheen and red-brown markings. On each, there is a large reniform mark, from which the moth is named. The hind wings are dirty white at the base, shading to grey. The Cabbage moth exceeds the Dot moth in wing span by nearly half an inch. Its fore wings are brownish grey marked with sinuous yellow lines at the apices. The hind wings are grey at the base, shading to grey-brown and edged with white.

The females deposit their eggs on the food plants in the early summer; the Cabbage moth is usually the earlier. In a little more than a week the larvæ emerge and in both species they are exceedingly variable in colour; all shades from grey to green, from yellowish through brown to nearly black, may be found. They invariably assume the colour of the vegetation on which they are feeding, though whether, like the chameleon, they can change their colour or whether it is permanent, we are unaware. In a month or so, the larvæ, being fully fed, pass to the ground to pupate, in which state they remain for the winter in the case of the Dot moth, but the Cabbage moth has two broods in a season.

Hand-picking again is the best remedy where feasible, and in these two cases it may be carried out by day. Turning over the ground in autumn and winter will expose a large number of pupæ to the attacks of insectivorous birds.

Our last example of lepidopterous farm pests also belongs to the *Noctuidæ*, but it has quite distinct habits and attacks different crops. The Corn Stem

FIG. 24. HEART AND DART MOTH, *Agrotis exclamationis*, L

FIG. 25. CABBAGE MOTH, *Mamestra brassicae*, L

FIG. 26. STRIPED CLICK BEETLE, *Agriotes lineatus*, L.

FIG. 27. COCKCHAFER, *Melolontha vulgaris*, F

moth, *Apamea secalis*, L., is essentially a pest of cereals; its larvæ have been taken on wheat, oats, barley, and cocksfoot. The moths, which measure about an inch in wing span, are so variable in colour that it is impossible to describe them in a few words. The fore wings may be grey, various shades of brown to nearly black, each one being marked with a light spot; the hind wings are light brown at the base, shading off towards the apex into dark brown.

The females deposit their eggs on grasses in the summer, and the larvæ, which vary in colour through all shades of green, attack the plants in a characteristic manner, which may best be described in the words of Curtis, who first drew attention to this pest. He says: "The habit of this caterpillar is to crawl up a fresh stem of wheat about four inches from the ground and stop at the apex of the sheath, at which point it is expanded into the blade, where it commences gnawing a hole in the main stem, with its head downwards; and in the course of a few hours it thus completely buries itself in the tube of the stem. Having eaten the main stem quite through, it usually falls out of the sheath; where therefore these fallen pieces are seen on the ground, they readily lead to a discovery of the caterpillar. It will continue thus within the sheath secure from observation, gnawing the tender stalk regularly round within, until it has consumed every portion of it quite down to the root, leaving the sheath partly occupied with its fæces. When the caterpillar has destroyed one stem, it crawls out to attack a fresh

one in a similar manner." Pupation takes place in the soil.

It is probable that crops are attacked by insects which have previously flourished upon grasses, and the best method of preventing such visitations is to plough the grassy headlands in the vicinity, as far as possible.

Coleoptera

Wireworms are such well-known pests that everyone who has cultivated anything must have encountered them. Wireworms are the larvæ of beetles belonging to the family *Elateridæ*, and are so called because they resemble short lengths of wire and also, we suppose, because they are not worms. Whoever dispensed the popular names of our British insects had a happy sense of the inappropriate. The adults are also known as Click beetles and Skip Jacks—Click beetles because they can bend their head and thorax at an angle, and then suddenly straighten them into line, making at the same time a moderately loud click; Skip Jacks because, when they find themselves on their backs, by going through the above process, they jump into the air with every chance of landing on their feet. There are three common species in this country; the Striped Click beetle, *Agriotes lineatus*, L. (fig. 26), is the commonest, and as the habits of all three are practically identical, it may serve as our example.

The adult is nearly half an inch long and of a general buff colour. The thorax is of this colour,

and the wing-cases are brown, striped with yellowish brown. Practically every kind of farm and garden crop suffers from the ravages of these pests, but cereals of all kinds, Crucifers, carrots, and strawberries appear to be among the favoured food plants. The beetles which are active on the wing deposit their eggs on or near the roots of the food plants in the spring. When the wireworms hatch therefrom they penetrate the soil to the roots, on which they feed. The larval stage extends over a period of three years, and, during the whole of this time, feeding often takes place without ceasing. It is obvious, therefore, that these insects are serious pests. When fully fed the wireworm is nearly an inch in length and of a lustrous straw colour. At this stage the roots are deserted for the first time for three years, unless a hard frost has forced the larvæ to penetrate deeper in the soil temporarily. Pupation takes place in the soil, and in little more than a fortnight the adults appear.

The so-called remedies for this pest are as numerous as its food plants. In small plots, traps for the larvæ consisting of pieces of potato, carrot, or beet may be buried for a few days, then lifted and destroyed, or the bait may be poisoned with equal effect. On the subject of the prevalence of wireworms we would emphasise Collinge's remarks in the strongest terms; he says: "The ruthless destruction of plovers' eggs during recent years, undoubtedly has much to do with the great increase of wireworms. The remedy lies very much in the farmer's own hands; so long

as the plovers' eggs are collected and sold in the numbers they are to-day, so long will wireworms and many other pests flourish."

Beetles in no way related to the Click beetles and totally dissimilar in appearance, yet bearing many points of resemblance in habits, are the Chafer beetles. There are four British species, the Green Rose Chafer, *Cetonia aurata*, Curtis, mentioned elsewhere; the Summer Chafer, *Rhizotrŏgus solstitialis*, L.; the Garden Chafer, *Phyllŏpertha horticola*, L.; and the Cock Chafer, *Melolŏntha vulgaris*, F. Of these, *aurata* belongs to the *Cetoniidæ*, *horticola* to the *Rutelidæ*, and the other two to the *Melolonthidæ*.

The Summer Chafer is chestnut-brown to straw-coloured, with four ridges on each wing-case, and measures rather less than an inch in length. The Garden Chafer is very variable in size, being usually half an inch or less in length; its head and thorax are dull green and the wing-cases chestnut-coloured. The Cock Chafer (fig. 27) is the largest of the group, measuring an inch in length. Its head and thorax are very dark brown; wing-cases chestnut; each one bears five ridges and a coating of hairs. Each side of the abdomen is marked with five white patches, and its apex projects beyond the wing-cases.

Collectively, these insects do a considerable amount of damage, both in the larval and adult stages, damage which is aggravated by the fact that occasionally the beetles appear in enormous numbers. Not only are cereals attacked, but also forest trees, particularly oaks.

We may take the Cock Chafer as our example, for the life-histories of these beetles are very similar in all essentials, except that in the case of the Summer and Garden Chafers the life-cycle is completed in a year. The female Cock Chafer, flying by night, goes below ground in early summer to lay her fifty or more eggs in batches of a dozen or so on or near the roots of the food plants. In rather more than a month the larvæ make their appearance, or more correctly emerge from the eggs, for they remain hidden below ground all the time. Till the fourth summer after hatching they continue to feed upon the roots of every conceivable crop. Frost alone drives them deeper into the soil and puts an end to their depredations for a time. The larvæ of all four species are very similar in appearance, and, except in size, can only be distinguished by the expert. The Cock Chafer grub, however, differs from the Rose Chafer grub described on page 84, by the fact that it is not hairy. When fully fed, pupation takes place in the soil, and the adults appear in the following spring.

It is of interest to note that though the habits of these beetles are so similar in many respects, the Garden and Rose Chafers are active only on bright, warm days, whilst the Summer and Cock Chafers are active at night.

Much good may be done, in the case of Cock Chafers, etc., by hand-picking and destroying the adults. The system may appear antiquated and tedious, but, in the case of these insects at any rate,

the method may have far-reaching results. Collinge, on this subject, says: "The efficiency of such a method of suppressing this pest is well illustrated by some figures given by M. J. Bernard before a meeting of the Société Nationale d'Agriculture of France. In the district of Meaux (Seine et Marne), a system of collecting the beetles was commenced, and the data are given in periods of three years, and show a steady decrease. The numbers for 1889 are 314,943 lbs.; for 1892, 268,490 lbs.; for 1895, 77,506 lbs.; for 1898, 229,515 lbs.; for 1901, 73,590 lbs.; and for 1904, 53,919 lbs. This gives us a total of nearly 1,018,000 lbs., or say 454 tons; and the number of beetles may be put down at 500,000,000, or an annual average of 28,000,000. One may perhaps form some better idea of the quantity when it is stated that it would fill two goods trains of twenty-three trucks each, each truck carrying ten tons.

"In this case these were collected by women and children, and the cost for eighteen years amounted to £4800, which, distributed over 315,000 acres, works out at about one halfpenny for every two and a half acres per annum."

The larvæ may be destroyed by the injection of carbon bisulphide into the soil.

Diptera

Flies play a very prominent part in agricultural economy. There are no fewer than nine decidedly destructive species in this country: that is to say, species which may be classed as major pests of farm

crops. Of these the Hessian fly, *Cecidomyia destructor*, Say, a pest of wheat, barley, and rye, was fully described in *Insects and Man*.

A destructive pest of Crucifers and one that is all too common in Britain is the Cabbage Root fly, *Phorbia brassicæ*, Bouché. Of cultivated plants, it attacks cabbages, turnips, swedes, radishes, and cauliflowers, whilst it does not disdain such wild plants as hedge mustard and shepherd's purse. The fly belongs to the family *Anthomyiidæ*, a family which numbers several pests among its members. In appearance it closely resembles the Onion fly (page 108), but may be distinguished, in the males at any rate, by the narrow transverse band on each abdominal segment. The females are lighter in general colour and in surface markings.

In spring the adults are active and the females deposit their eggs, to the number of forty or fifty, either on the food plant near the ground or on the ground. Washburn, who has devoted considerable attention to this pest, describes the act of oviposition in the following words: "When a fly lights on a plant in search of a place to deposit her eggs, she runs quickly down the stalk to the ground. Here she searches alternately with her forward and rear end or ovipositor, for some crevice or crack through which she can obtain access to the stalk of the plant underground. She acts rather nervously, occasionally running up on to the leaves. The ovipositor is, when extended, nearly as long as the abdomen, very flexible and pointed. With this she tries every place offering

any chance of furnishing what she desires. When she has finally found a crevice, she forces the ovipositor in to the limit, and stands still for several seconds, meanwhile usually polishing her head with her fore pair of legs. She then withdraws her ovipositor and, after climbing on to the plant again, flies with a slow flight near the ground to a point of vantage or to another plant. I watched five flies at work, and they all laid eggs while I was watching them. Only one of them laid more than one egg in a place, and she laid two. The eggs were carefully concealed, and were not visible from outside without disturbing the soil."

The larvæ attack the roots of the food plants; at times also the stems are attacked. In any case the leaves soon wither and the whole is reduced to a rotting mass. In three weeks the time has arrived for pupation; the grubs, which are cream-coloured and legless, as in all dipterous larvæ, are about a quarter of an inch in length. A brown oval puparium is formed, either in the soil or in the food plant; the former is the more usual. In this stage the winter is passed. There are three broods in a season.

Rotation of crops is essential in order to eradicate the pest. Sand, soaked in paraffin and distributed amongst the growing plants, is recommended. Washburn suggests carbolic acid and lime, or glue and bran, to be used in the same manner. Cruciferous weeds should, of course, be destroyed.

Another fly of the same family, though far less destructive, probably because it is not so widely spread, is the Wheat Bulb fly, *Hylemyia coarctata*, Fl.

This fly, which is a pest of wheat, also flourishes upon various wild grasses, notably meadow foxtail and couch. In appearance it is very similar to its relative the Cabbage Root fly, in habits it somewhat resembles the Frit fly. The precise life-history of the pest is not known, but the larvæ burrow down between the leaf-sheaths of the food plants till they reach the growing point, which they often destroy. Pupation may take place either in the soil or on the plants.

Of efficient remedies there appear to be none; some of the crop may be saved, however, by a dressing of nitrate of soda, with the object of accelerating growth.

A much more serious pest is the Gout fly, sometimes known as the Ribbon-footed Corn fly, *Chlorops tæniopus*, Meign. It belongs to the family *Chloropidæ* and is destructive to wheat, barley, and rye; it also lives upon timothy, couch, meadow foxtail, and other grasses.

The flies are black and yellow, with transparent wings; in length they are about one-sixth of an inch. The head and thorax are yellow; on the former there is an angular black patch, on the latter three black stripes; the yellow abdomen is barred with olive-brown. The legs are yellow and black. In late spring the females deposit their elongated pale-green eggs, singly or in pairs, on the outer sheathing leaves of the food plants. When the larvæ emerge, they at once attack the base of the developing ear, and then tunnel downwards to the first node. As a result of this attack the ear never bursts from its leafy case,

the whole plant becomes stunted, and its lower portions become inordinately swollen. This swollen appearance of the infested plants is characteristic and has earned the insects their popular name of Gout flies. Within the plant, still at the point of the first node, the cream-coloured larva pupates. The puparium is about a fifth of an inch in length, and brown in colour. In about a fortnight the adults of the second brood appear, and the females oviposit on wild grasses or on autumn-sown corn. Winter is passed in the larval stage, and gives rise to the spring brood in the following year; there are thus two broods in a year.

There are no efficient remedies for this pest; methods of prevention, however, may be profitably put into execution. Wild grasses, on which the larvæ pass the winter, should be destroyed wherever possible. Autumn sowing should be as late as is feasible, and spring sowing correspondingly early. By this means the females of the second brood will have oviposited on the wild grasses before the autumn corn appears, and the spring corn will have come into ear before the early females are on the wing.

The Frit fly, *Oscinis frit*, L., is, at times, a troublesome pest of oats and barley. Its popular name requires some explanation. In Sweden, shrivelled corn plants are known as "frits," and the damage done by these insects gives rise to a shrivelled appearance, hence the name Frit fly.

The flies are little more than an eighth of an inch in length, lustrous black in colour, with black and

yellow legs. They are exceedingly active and move from plant to plant with a characteristic jumping action. They appear in the spring and the females oviposit on the leaves of the food plants, depositing, usually two, and sometimes four eggs on each plant, to the number of seventy in all. The dirty-white, legless grubs penetrate to the centre of the stems, causing the leaves to turn rusty brown and to wither. Pupation takes place within the plant, and the chestnut-brown puparium may be easily recognised by two minute protuberances on its anterior end and two larger ones posteriorly. In the summer, adults of the next brood appear. The females of this brood oviposit on the ears, upon which the larvæ feed when they emerge. A third brood appears in late summer, and this time oviposition takes place upon wild grasses, winter being passed in the pupal stage.

The suggestions given for dealing with the Gout fly may also be utilised in this case.

Perhaps the most familiar of all farm pests is the Crane fly or Daddy Longlegs (fig. 28). The popular name includes two common species, *Tipŭla oleracea*, L., and *T. paludosa*, Mg. The insects are too well known to need description; the former species is greyish yellow in colour and the latter is brownish red. The males may be distinguished from the females by the abrupt termination to the abdomen, whilst the apex of the female abdomen is pointed. Except that *oleracea* is on the wing in the spring till summer, and *paludosa* from summer to autumn, the two life-

histories are almost identical, as far as they are known. Here again we have insects so common that they almost force their presence upon us in the summer months, yet their life-histories have not been fully studied, and there is considerable difference of opinion concerning various points. This much, however, is established. The females fly slowly over the ground in a vertical position, with their long hind legs trailing thereon. As they go along they deposit their elliptical, lustrous black eggs, to the number of three hundred. In a fortnight or so the larvæ emerge and at once pass into the soil. The larvæ are well known and have been termed leather-jackets on account of their leathery skins. When full-grown they are about an inch long and variable in colour, from grey to brown; at the retractile head end they are pointed and armed with strong jaws; their tail end is blunt and furnished with tubercles. While below ground the larvæ feed upon, and damage, the roots of all manner of plants—cereals, clover, peas, cabbages, sprouts, and beans among others. All kinds of grasses suffer from their attacks; they often do considerable damage to lawns and would do more, were they not eagerly sought by starlings. Pupation takes place below ground, and the pupa bears considerable resemblance to the larva; it is furnished with an anterior pair of curved, horn-like processes, and is also armed with a row of spines on each segment. When the time arrives for the adults to emerge, the pupa, which is decidedly active, wriggles to the surface of the soil with the aid of its spinous

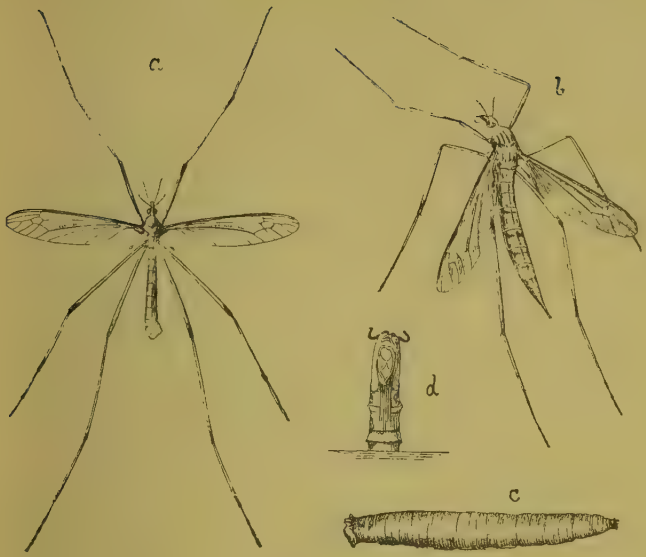


FIG. 28. CRANE FLY, *Tipula oleracea*, L. *a.* MALE; *b.* FEMALE; *c.* LARVA; *d.* PUPA

FIG. 29. OX GAD FLY,
Tabanus bovinus, L.

armour. Projecting half way above ground, the pupal case splits and the adults emerge, leaving the empty case *in situ*.

Crane flies are partial to damp soil, therefore efficient drainage is necessary in order to check them. Ditches also should be kept well cleaned. Following an attack, the ground may be advantageously dressed with gas lime, and, in small plots, much good may be done by periodical hoeing, thereby exposing the leather-jackets to the attentions of insectivorous birds.

The Mangold fly, *Pegomyia betæ*, Curtis, is another common agricultural pest. As far as cultivated plants are concerned, its attacks are confined to the leaves of mangold plants, but they are often sufficiently serious to be the cause of considerable financial loss. The flies measure rather more than a quarter of an inch in length and are of a dark grey colour. In shape and general appearance they closely resemble the common house-fly. In late spring and early summer, just as the mangold seedlings are beginning to appear, the females deposit their white oval eggs, from one to four, on the under surfaces of the leaves. In less than a week the larvæ emerge and bore their way through the lower epidermis of the leaf to the tissue within. They feed upon the leaf mesophyll, causing unsightly blisters, and, of course, reducing the area of assimilatory tissue, with the result that the plant is unable to manufacture its reserve food. In severe attacks the plants are killed. After a month or so the cream-coloured, legless larvæ are fully fed and measure about a third of an inch in

length. They may either fall to the ground to pupate or make the change within the blisters which they have formed in the leaves. In the latter event, the ruddy-brown puparia may easily be seen, through the epidermis of the leaf. In a fortnight or less, adults of the second brood appear, and the life-cycle is completed once more before the end of the year, winter being passed in the pupal stage, below ground. In addition to mangold, these flies attack various thistles, docks, and dandelion, and, when mangolds are not to be found, the race is continued on these plants.

When the flies are observed about mangolds, a prompt spray of paraffin emulsion will probably prevent the larvæ, when they emerge, from penetrating the leaves. Later, this procedure would be useless, for the larvæ, hidden within the leaves, would not be touched by the liquid. When this stage is reached, the best remedy is to apply a top-dressing of nitrate of soda, in the hope that the mangold may make rapid growth and survive the attack.

CHAPTER VII

INSECTS HARMFUL OR ANNOYING TO DOMESTIC ANIMALS

JUST as mankind himself is, in Britain, immune from many of the fell insect-borne diseases which attack his brethren in the tropics, so are his cattle in an equally happy state. Lest it be thought that we make light of the activities of our native insects, let us hasten to add that, though man and his belongings are spared some of the more dread maladies, there are pests among us which can by no means be dismissed as of no account.

DIPTERA

Amongst the British insects which are noxious to horses and cattle, the blood-sucking flies deserve pride of place. In this category we include only those flies whose mouth parts are provided with lancet-like organs, capable of piercing the skin. Other flies, it is true, also suck blood, but, not being provided with piercing mouth parts, they can only obtain their liquid refreshment at some spot where the skin has already been pierced, either accidentally or by disease.

The majority of blood-sucking flies belong to the

family *Tabanidæ*, a family which includes some of the largest and most bloodthirsty members of the order. These flies have been given various popular names in different parts of the country, and are known as Gad flies, Breeze flies, and Horse flies. They include some of the largest of our British Diptera, and, in general, may be recognised by their large heads and broad, flattened abdomens. In each species the males may be distinguished from the females by the fact that their eyes meet in the centre over the head, whereas there is a distinct space between the eyes of the females. As the latter alone are noxious, for the males are vegetable feeders, they should be specially guarded against.

The adults may be described as summer flies, for it is in the summer time, and then only on hot, sunny days, that they are really active. On such days, the insects fly with extreme rapidity, to the accompaniment of a loud and characteristic buzzing. The females deposit their eggs in moist situations, either on the soil or on vegetation; the larvæ live on vegetable matter and either pupate thereon, or in the soil.

There are more than a score of species of Gad flies in Britain, so we can only consider a small proportion in these pages. The largest of our native species is the Ox Gad fly, *Tabānus bovinus*, L. (fig. 29). In length it measures nearly an inch and is, dorsally, of a general red-brown colour. On the thorax there are five faint, buff-coloured, longitudinal stripes, and there is a pale

stripe along the centre of the abdomen. Ventrally, the abdomen is orange, except for the apex, which is dark brown, and a median stripe of the same colour. The eyes of the male are vivid green, and those of the female, copper-coloured. The females are active in the summer months, especially near woods and water, and cause much annoyance to cattle and horses.

Later in the summer the place of the Ox Gad fly is taken by a smaller though no less annoying member of the same genus, the Autumnal Breeze fly, *Tabānus autumnalis*, L. It may be distinguished from the preceding species by its smaller size, rarely exceeding three-quarters of an inch in length, and by its colour. Its general colour is dark brown; the grey thorax bears four brown stripes, and on the abdomen are three rows of light spots.

The Blinding Breeze fly, *Chrysops cœcutiens*, Meig. (fig. 30), earns its popular name from its annoying habit of attacking cattle around their eyes. Members of this genus may be distinguished from those of the genus *Tabanus*, among other things, by the apex of the abdomen, which terminates abruptly, whereas in the *Tabanidæ* it is more or less pointed. The insect under consideration has a dull-green abdomen, yellow at the base. The wings are brownish, with a clear patch at the base and another near the apex. Their yellowish-green eyes are lined and dotted with purple.

The Rain Breeze fly, *Hæmatopota pluvialis* (Meig.), is one of the most persistent of the blood-sucking

flies, and is more in evidence in heavy, thundery weather than at other times. It lives in the vicinity of streams and is a cause of annoyance to beast and man. About half an inch in length, of a dark grey colour, with dappled, overlapping wings, it is an easily recognised species.

These pests are difficult to deal with; all of them, however, frequent water for drinking purposes, and a number may be destroyed by pouring paraffin on the surface of such drinking-places, where feasible. Various greasy preparations with which stock may be covered are on the market. Many of them serve their purpose well, but they only keep the flies away and do not reach the root of the evil by destroying them.

Amongst the *Muscidæ*, the family to which the house-fly belongs, there are one or two blood-sucking species in this country. The family includes the dreaded tsetse flies, some of which act as transmitting agents of the fell disease known as sleeping sickness. Tsetse flies, however, do not occur in Britain, so we need not trouble about them here.

A very common muscid is the insect known as the Stable or Storm fly, *Stomoxys calcitrans*, Geoff. Stable fly it is called because it frequents stables, especially in stormy weather; Storm fly because the virulence of its attacks is more pronounced when the days are unsettled. Both sexes of the fly attack cattle, horses, and man. Its awl-like mouth parts are sufficiently powerful to penetrate one's clothing. Horses are usually attacked on the legs, with the

FIG. 30. BLINDING BREEZE FLY,
Chrysops caecutiens, MEIG

FIG. 31. FOREST FLY, *Hippobosca equina*, L

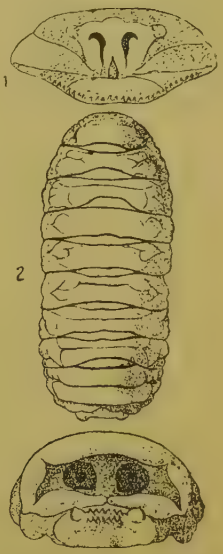


FIG. 32. LARVA OF SHEEP BOT FLY, *Oestrus ovis*, L.
1. ANTERIOR SEGMENT;
3. POSTERIOR SEGMENT;
2. DORSAL VIEW

formation of large papules wherever the skin has been punctured.

The adults bear considerable resemblance to the house-fly. They measure from one-third to half an inch in wing span. In colour they are brownish, shot with green; on the dark-brown thorax there are three longitudinal pale stripes, of which the central one is golden yellow at its anterior extremity. The brown abdomen is spotted with darker brown. When at rest, its awl-like mouth parts project horizontally, reaching beyond the head, and the presence of this organ, in itself, distinguishes this insect from the house-fly.

The female deposits from fifty to seventy white, elongated eggs either in decaying vegetable matter or in manure. In a short time, cream-coloured, lustrous, yet somewhat translucent, legless larvæ emerge, feed upon the material in which the eggs were laid, and become full-fed in a fortnight to three weeks, when they change into oval, brown puparia. The pupal stage lasts from seven to fourteen days, so that the whole life-cycle is completed in from rather more than three to five weeks.

When the flies are found in stables in large numbers, they may be cleared therefrom by burning fresh pyrethrum powder. As a preventive, there is nothing better than to destroy all likely breeding-places.

Flies very similar to the Stable fly, only considerably smaller, are the Horn flies, so called because they settle in large numbers on the bases of the horns of cattle. Two species occur in Britain, the Irritating

Horn fly, *Hæmatobia irritans*, Meig., and the Exciting Horn fly, *Hæmatobia stimulans*, Meig. Both species are insects of the open air, frequenting woodlands and pastures; they never enter houses and stables, after the manner of the Stable fly. They are troublesome to cattle and horses, attacking them chiefly on the shoulders, often with such effect as to produce considerable sores. Apart from their annoyance to stock, they claim attention by reason of the remarkable rapidity with which the life-cycle may be completed under favourable circumstances. No time is wasted by the females in depositing their eggs, which are laid in fresh manure. In about twenty-four hours the larvæ appear, feed upon the manure, pass to the soil below to pupate, and in a fortnight after oviposition a new brood appears.

In order to keep Horn flies within reasonable bounds, all fresh manure in pastures should be covered with lime.

The family *Hippoboscidæ* comprises flies of very peculiar and unusual structure. All the members of the family are parasitic, some upon quadrupeds and birds, others upon bats and even upon bees. Of our British species, the Forest fly, *Hippobosca equina*, L. (fig. 31), and the so-called Sheep tick or ked, *Melophagus ovinus*, L., the former is parasitic upon horses, mules, donkeys, and sometimes upon cattle and dogs, the latter upon sheep.

The Forest fly is a local insect and its chief haunt is the New Forest. The adults are rather less than three-eighths of an inch in length. The head, abdomen, and

legs are yellowish brown, the thorax is brown marked with three yellow spots. Their skins are hard and leathery and their short legs are armed with large and sharply pointed claws. They may be described as crab-like creatures, if such a term can be applied to insects, and the resemblance is accentuated by their habit of rapidly running sideways.

They chiefly attack the stomach and flanks of their hosts, clinging to the covering hair with their large claws. They obtain their nourishment by sucking blood, but are chiefly noxious on account of the intense irritation set up by their claws, as they crawl over their host's skin. They occur during the summer months and, at that time, any New Forest pony will yield dozens of specimens, or they may be seen taking short flights from host to host. The Forest fly differs from all the Diptera we have so far studied by the fact that the female does not deposit eggs. The life-history is most peculiar. Larval development takes place within the body of the mother fly, and she increases her kind by depositing puparia. Usually, when a stage in the normal life-cycle is, so to speak, skipped, the result is a great increase in the number of individuals—the production of living young by the Aphides is an example. Each female Forest fly, however, only produces a very few puparia.

The only method of dealing with this pest is to smear horses or cattle with some substance, such as paraffin, which is distasteful to the flies.

The so-called Sheep tick—which, by the way, is not a tick at all, but is so called on account of its tick-like

habits—is a small wingless creature measuring, in the case of the females, little more than an eighth of an inch in length. The males are smaller. It is truly parasitic upon the sheep, being wingless and armed with strong claws, which enable it to hold on to the wool of its host. In general colour it is rust-brown with a grey-dappled abdomen; the whole insect is thickly clothed with brown hair.

During its whole life-cycle the insect lives upon its host. As in the case of the Forest fly, eggs are not laid, but the female produces, in all, about five cream-coloured, ovoid, shining, moderately flattened larvæ (fig. 32). These hatch within the body of the mother fly and are deposited in an advanced stage of development. Each larva is fixed by the mother to the wool of the host, and almost immediately transforms into an oval, shining, copper-coloured puparium, which rapidly turns almost black in colour. These dark-coloured puparia have much the appearance of apple pips, but they are sometimes heavily incrusted with the white, sticky substance by means of which they are attached to the wool.

Nourishment is derived by these parasites from the natural grease exuded from sheep's wool, from various skin secretions, and from the hosts' blood, which their sucking mouths are well adapted to obtain.

These insects cause considerable annoyance to adult sheep, and, in severe attacks, loss of condition results. To lambs the parasites are more serious and may cause death. Careful dipping and the isolation of sheep known to be infested are the only remedies.

The family *Œstridæ* is rich in animal pests. Three common British members of the order are the Sheep bot fly, Nostril or Nasal fly, *Œstrus ovis*, L., the Horse bot fly, *Gastrophilus equi*, L., and the Ox Warble flies, *Hypoderma bovis*, de G., and *H. lineata*, Vill.

The Sheep bot fly was one of the earliest pests of domestic stock to be discovered. It was mentioned in Greek writings more than a thousand years ago. The adult, which measures about half an inch in length, is of a general yellowish-brown colour. The abdomen appears velvety and is dappled with dark-brown and straw-coloured marks. The head is white below, furnished with short antennæ and purple-brown eyes. The flies are heavy-looking, and they do not belie their looks, for the only occasion on which they display any great amount of activity is when they are attempting to deposit their eggs on some luckless sheep. They do not even feed, for they have no mouths; their only object in life is to increase their kind.

The adults are active on warm, sunny days from May to October. In dull weather they hide in any convenient dark crevice, but with the advent of the sun they become more lively. The females may either produce eggs or living larvæ. There appears to be no definite evidence as to what conditions control the production of eggs or larvæ, but it has been suggested that the latter are produced in hot weather. At any rate, the progeny, whether eggs or larvæ, are deposited by the female fly on the nostrils of the sheep. The eggs are white and curved and hatch in a very short time, giving rise to cream-coloured, leg-

less grubs, which at once pass up the nasal passages of their host, till they reach the cavities lying between and rather above the eyes, known as frontal sinuses. The larvæ in their travels cause intense irritation and much discomfort to their hosts. The grubs, by means of hooks on either side of their heads, attach themselves to the membrane lining the frontal sinus. This lining membrane secretes mucus, on which the grubs feed. When fully fed, after ten months, they are nearly an inch in length, white at the anterior end, shading to dark brown posteriorly, and armed with a number of spines, all pointing backwards. At this stage the hold on the sinus membrane is relaxed and, by means of their spiny armour, the larvæ once more pass to the nasal passages of their host, by whose violent sneezing they are expelled. Once on the ground they quickly bury themselves, and within forty-eight hours change into a brown puparium, which later turns black ; after a lapse of forty to fifty days the adults emerge.

Sheep which are known to be attacked should be isolated from others. Little can be done for the sufferers, but fumigation with substances which will cause violent sneezing may result in some of the larvæ being expelled. In the case of valuable animals it may be thought expedient to operate. By anointing the nostrils of the sheep with fish oil or some similar substance the flies may be prevented from ovipositing.

The Horse bot fly, to which the name Horse Bee has also been applied, is a hairy insect rather less than three-quarters of an inch in length. In colouring it

is variable, usually of a general brown shade; the front of the head is white and the abdomen is marked with three rows of blackish spots. The adults are active during the summer months, particularly in August, and they are troublesome not only to horses but to mules and donkeys.

The females are very persistent in their egg-laying operations. Hovering vertically near their victim, they will make a sudden dart, deposit a single egg upon a hair, retreat a short distance, and then repeat the operation till a number of eggs are laid. Oviposition always takes place on some place which may easily be reached by the tongue of the host, such as the forearm or knee. The eggs, which are rather less than a sixteenth of an inch in length, are white when newly laid and turn pale yellow after a while. They are roughly conical in shape and are affixed to a hair by their narrower ends, whilst the obliquely truncated broader ends are provided with lids.

The deposition of the eggs appears to cause no inconvenience to the host, but later, irritation is set up by their presence. The horse licks the offending spot and, of course, the eggs as well; the lids are opened by the moisture and friction of the animal's tongue, upon which the larvæ are set free. The newly hatched larvæ are long, worm-like, and transparent, and composed of thirteen segments. Growth is very rapid and probably takes place at the expense of the mucus, secreted by the mouth and gullet of the host. Quickly the larvæ pass to the horse's stomach and undergo considerable changes in structure and

appearance. Round the mouths of the grubs, in their stomach-frequenting stage, there are a number of hooks; these are used to anchor the insects to the stomach wall. The tail end is considerably swollen, and provided with spiracles for breathing purposes. Attached in this manner, the larvæ obtain their nourishment both from the tissues to which they are attached and from the stomach contents. In the spring, after nearly a ten months' sojourn in the stomach of their host, they are fully fed and measure nearly an inch in length. Pupation takes place in the ground, which they reach by passing thereto with the excrement, after having released their hold on the stomach tissues of their host. In less than forty-eight hours after reaching the ground, the brown puparia are formed, later they turn black, and in a month or so the adults appear.

The maggots cause considerable inconvenience to their hosts at best, and have been known to cause death. They sometimes occur in extraordinary numbers, as many as a thousand having been taken from a single stomach. Though the attacks of this pest are distressing, there is one redeeming feature in that the host is periodically free from the larvæ. Little or nothing can be done to hasten the departure of the unwelcome visitors without, at the same time, damaging the internal organs of the host. Prevention of attacks, in the shape of anointing horses with substances noxious to the flies, thereby preventing oviposition, is the best method of dealing with the pest.

Of the two British Ox Warble flies, *Hypoderma lineata* is the commoner and therefore responsible for the most damage. The results of attacks by these insects not only concern the stock-keeper, but also the butcher and the leather merchant. Milch cows when attacked yield a reduced milk supply, meat from warbled beasts is often useless for human consumption, and the loss in damaged hides alone, in a single year, in Manchester, Newcastle, and Nottingham, has been estimated at £33,715. The wearing properties of warbled hides are said to be thirty per cent. less than are those of sound ones, In Belgium, of 400,000 adult cattle slaughtered, 50,000 were found to be warbled; and the German *Agricultural Journal*, reckoning the annual loss caused by these flies in millions of marks, gives Holland seven, Germany ninety, and England one hundred and twenty! Not only do the larvæ themselves cause damage, but the adults, when on the wing, frequently cause the cattle to stampede, with disastrous results.

The adults are about half an inch long and very hairy. In general colour they are black, with white hairs on the head and the base of the abdomen: the thorax is clothed with white as well as brown hairs. They, like the Sheep bot flies, have rudimentary mouth parts and take no nourishment. The females only attack cattle on the hottest days, and during the warmest hours of the day. They shun shade and will not attack cattle near water. The females affix their eggs to the hairs on the backs of cattle on

either side of the spine. They are white, elliptical, and flattened, with an appendage by means of which they are attached to the hair of their host. In length they do not exceed one-twelfth of an inch. When the larvæ emerge they are whitish and worm-like; they are armed with a pair of crescent-shaped mouth parts and with several bands of spines. A hole is bored in the hide of the host, beneath which the larvæ take up their abode. As they become older, the "bots," as the larvæ are called, change very considerably in appearance, becoming, in turn, spindle-shaped, then oval, compressed, and warty. During the last stage the larva reposes head downwards in the subcutaneous cyst which it has formed. Its spiracles are directed towards the opening which remains in the warble, and by this channel air is obtained. Formidable spines form part of its clothing and, by raising and compressing them from time to time, a copious supply of pus is ensured, on which the larva feeds. When fully fed and measuring about an inch in length, the "bots" emerge from the warbles, usually early in the morning, fall to the ground, change into nearly black puparia either on or in the ground, and in from three to six weeks the adults emerge.

The presence of these insects or rather their larvæ may always be detected by the swellings, known as warbles, on the hide of the host. The larvæ, in passing from the host, make holes in the hide, thereby reducing its value for tanning purposes. The larvæ may be readily squeezed from the warbles, and by this means many may be destroyed. Cattle should

also be dressed with some noxious substance to prevent oviposition by the flies; grease and paraffin is efficacious. Plenty of shade should be provided, for, as we have already mentioned, the flies are only active in sunlight.

Another fly which is the cause of considerable loss to stock-keepers is the Sheep maggot or Green-bottle fly, *Lucilia sericata*, Meign. The flies are common, and they are easily recognised by their metallic green-blue colour. In wing span they measure about seven-eighths of an inch. In the warm days of summer each female deposits about five hundred cream-coloured eggs, in clusters of twenty to fifty, on the wool of a sheep. Each egg is approximately one-sixteenth of an inch in length and is actually fixed to a strand of wool. In twenty-four hours the larvæ emerge. They are cream-coloured and legless, and are provided with strong mouth hooks with which to tear the flesh of their host. While young, they feed externally upon the sheep, but, as they grow older, they become embedded in the flesh. In a fortnight they are fully fed and measure about half an inch in length. At this stage they pass to the ground and change into chestnut-coloured, barrel-shaped puparia. There are several broods in a season.

Lambs and old, unhealthy sheep are more liable to attack than others; those with soiled fleeces also are preferred. The activities of the maggots cause ugly sores, matting of the fleece, and general loss of condition.

All dirty and soiled wool on the sheep's hind

quarters should be clipped, when the eggs or maggots are observed; or as a preventive, a dip containing sulphur should be used, and all wounds should be dressed with spirits of tar.

MALLOPHAGA (wool eaters)

The Mallophaga or Bird lice form too large a group to be considered in any detail here. They are well adapted for the truly parasitic life which they lead upon birds of all species. They mostly have hard, horny, flattened bodies and mouth parts adapted for cutting the feathers and epidermal scales upon which they subsist. They have no wings, and their hind legs and feet are either adapted for running or for clasping. Although numerous species of these insects live upon poultry, we must content ourselves with a few words anent one, the Common Hen louse, *Menopon pallidum*, Nitzsch. This insect, according to Osborn, causes more annoyance to poultry than all the other species combined. It readily passes to other species of birds, and will even attack horses.

The Common Hen louse cannot easily be confounded with any other species. About a millimetre or rather more in length, it is of a light straw colour with a number of light spots upon the abdomen. It runs with great alacrity among the feathers of its host. The eggs, which are provided with a circular-lidded opening at one end, are glued at the other end to feathers by the female. In about a week, or rather more, active, soft-bodied larvæ emerge; they pass

through a dozen moults before reaching their full development.

The symptoms of an attack by these lice are well summed up by a writer in the *Poultry World*, who says: "Bowel disease in summer is a sign of lice; the sleepy disease in which the chicks are sleepy or drowsy, is a sign; refusal to eat, puny-looking body and slow growth, sudden deaths, gradual wasting away, constant crying, loss of feathers on the head, and other symptoms that appear surprising or remarkable. Even in the cleanest of houses, when not a sign of lice can be seen, look on the chick for the large lice. Not only on the chicks, but the large body lice are nearly always on the adults. A chick will never get lousy unless the old fowls are near, and that is why brooder chicks grow faster than those under hens. The large lice will kill ducks suddenly. They kill nearly all the young turkeys that die. Whenever you notice a sick fowl dusting itself, look for lice. No doubt a majority of our readers fully understand how to get rid of lice, but the fact is that they will not believe that lice are present, and ascribe the results of the work of lice to some disease, thus doctoring the birds unnecessarily. First, we wish to say that while you may easily discover myriads of little red mites in the poultry house, yet the real enemy is the large grey body louse which works on the heads, necks, and vents, and which never leaves the birds. To find this louse a very close search must be made, as he lurks down on the skin, at the base of the feathers, and hides from view. A single one of these voracious

fellows on the head or throat of a young chick will sometimes cause the chick to droop and die."

In dealing with poultry lice, cleanliness should be the first consideration. Poultry houses should be fumigated and afterwards thoroughly whitewashed. Dust baths should be provided, and the dust should be mixed with fresh pyrethrum powder. Chickens and sitting hens suffer most, and, where known to be infested, the former may be dressed with white precipitate; the latter may be dressed with the same substance as a preventive.

Linguatulidæ

Of all the creatures coming within the ken of the entomologist, none are more anomalous than the *Linguatulidæ*, endoparasitic Arachnidæ with elongated, worm-like bodies. They have no true legs, but these organs are represented by rudimentary structures which take the form of two pairs of hooks adjacent to the mouth

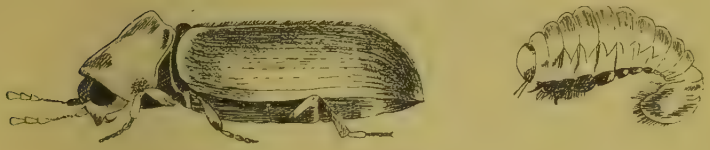
Linguatula serrata, Frölich (fig. 33), occurs in Britain. It was discovered by Weisberg in 1763 in the frontal sinus of the dog. Since then adults have been found in man, horse, mule, goat, wolf, and fox, and the larvæ in man, ox, goat, pig, cat, hare, guinea-pig, and porcupine. Weisberg considered the creature to be a leech on account of its external form; it is white, with a segmented vermiform body, flattened dorsi-ventrally, the upper surface being rounded, the lower flat. It is now known to be closely allied to *Demodex.*

The life-history of *Linguatŭla serrata* is as interesting as it is nauseating. The female lays her eggs in the nasal cavities of the dog. Violent sneezing is induced by the presence of the eggs and some or all of them are expelled, along with a certain amount of mucus. How many ladies who are in the habit of kissing their lap-dogs ever give a thought to *Linguatulæ*! Many of the eggs, when expelled, fall upon grass and there, surrounded by a film of mucus, they are enabled to withstand desiccation for several weeks. The chances are that this grass will be eaten by some herbivorous animal, domestic stock of some kind, or a rabbit, and then *Linguatŭla* can start on its career. Gastric juices dissolve the egg shells, and the ovoid, dorsiventrally flattened larvæ are set free in the host's intestine. Each larva is very minute, with four legs, and its head is armed with a perforating stylet and two curved hooks, by means of which it bores through the wall of the intestine to the liver or lungs, where it becomes encysted. That is to say, it loses its legs and perforating apparatus, and changes into a motionless pupa, three times as broad and nearly three times as long as the larva. After a series of moults it is transformed into a secondary larva. This occurs in the sixth or seventh month of its existence. At this period, although elongated, it is broader at the anterior end than at the posterior. In length it measures about one-fourth of an inch; it is segmented and has a mouth armed with four hooks, and its posterior extremity is covered with a series of fine

spines, by means of which it is enabled to pass to the peritoneal cavity. Once in this, which may be termed the abdominal cavity, one of three things may happen. The secondary larva may die, it may become encysted, or it may pass to the bronchial tubes and be ejected from the host by coughing. Development can only be completed in the respiratory apparatus. Should the viscera of an infected animal be eaten by a dog or other of the carnivora, the secondary larvæ will ascend to the nasal cavity either by way of the throat or by passing through the wall of the stomach, lung covering (pleura), and lungs. When the nasal cavity is attained, a moult takes place almost immediately, the spines and mouth hooks are discarded, and the adult is smooth. It shelters in positions where it is not subject to air-currents and feeds on mucus. Pairing takes place within the host and, as a result, the female increases considerably in size. About six months after reaching the nasal cavity oviposition takes place; each female is said to lay from five to six hundred eggs.

The best preventive to the spread of *Linguatŭla serrata* is not to feed dogs on the uncooked viscera of sheep, rabbits, etc., which may contain the larvæ. Sporting and sheep dogs are more liable to attack than house dogs, simply because they more often run the risk of infection. This, however, is no excuse for the inordinate fondling of pet dogs, which nauseates no one more than the true dog-lover.

FIG. 33. *Linguatula serrata*, FRÖLICH



A B

FIG. 34. *Anobium domesticum*, FOUR. *a.* ADULT; *b.* LARVA

FIG. 35. LARVA OF HOUSE FLY, *Musca domestica*, L

FIG. 36. LARVA OF LESSER HOUSE FLY, *Fannia canicularis*, L

CHAPTER VIII

HOUSEHOLD INSECTS

UNDER this heading, we propose to deal with a selection of the commoner insects which are in the habit of frequenting our houses. Lest our title, which we have chosen for want of a better, prove misleading, let us point out that any insect may find its way into our dwellings by accident. There are, however, a number of species which habitually dwell in human habitations, and these, and these alone, we call household insects. Many such creatures also frequent stores and warehouses, and our treatment of the latter in a separate chapter must not be taken as an intimation that they are not likely to be found in houses. Some household insects, the majority in fact, are harmless to mankind himself, contenting themselves with damaging his property rather than his person. The personally harmful species, at any rate in so far as their disease-transmitting habits are concerned, are treated in our concluding chapter.

LEPIDOPTERA

The most injurious of the household Lepidoptera are undoubtedly the Clothes moths. Three species

are common in this country, the Case-making Clothes moth, *Tinea pellionella*, L., the Webbing Clothes moth, *Tineola biselliella*, Hum., and the Tapestry moth, *Trichophăga tapezella*, L. The Case-making Clothes moth is the commonest species and is often extraordinarily destructive. How long these insects and their habits have been known it is hard to say, but the results of moth attack are mentioned in Biblical times, on more than one occasion. All three belong to the family *Tineidæ*, which includes several species harmful in the garden and orchard. The Case-making Clothes moth measures but half an inch in wing span. Its fore wings are greyish yellow and each bears three dark spots; its hind wings are paler in colour and edged with long, hair-like scales.

Stray moths may be seen at almost any season of the year, but they are more prevalent in the spring and summer. The female deposits a number of very minute eggs, so small as to be just visible to the naked eye, on some substance which will furnish food for the larvæ. Woollen goods, carpets, furs, and even silks are the articles usually selected. The white larvæ, immediately on hatching, make a case to serve as a protection during their feeding period. The case is tubular, open at either end, and rather wider in the centre than at the ends; it is composed of portions of the material on which the eggs were deposited and is silk-lined. Within this case the larva lives, thrusting its head therefrom to feed and withdrawing therein when alarmed. After

feeding for some time the larva grows too big for its home, then it starts on rebuilding operations. Without leaving the case, a slit is made down one of its sides and a triangular gore of fresh material is inserted. Turning round within its home, the operation is repeated at the other side, and the reconstruction is completed by the addition of more material at either end. By moving the larva from material of one colour to material of another, a multi-coloured case will be built, for it is always formed from the food material of the insect. When fully fed, towards autumn, the larva either affixes its case to the substance which has provided food or drags it to some hiding-place. Hibernation takes place within the case and pupation also, in the spring. Three weeks later the moths emerge.

The Webbing Clothes moth is rather larger than its case-making relative, is yellower in colour, and has no spots on its fore wings. The food material is similar in both insects and, in addition, it occasionally selects animal substances such as museum specimens and cobwebs. The larvæ have been reared experimentally on the last-named food. No case is made by this larva, but it pupates within a silken cocoon to which are attached portions of the substance on which it has been feeding.

The Tapestry moth is a still larger species, measuring about three-quarters of an inch in wing span. Its fore wings are greyish white at the apex, with the exception of a small black patch at one tip, and black at the base; the hind wings are pale

grey and fringed as in the other species. The material attacked by the larvæ of this moth is of a coarser description than that favoured by its relatives. In this species too, no case is made, but the larvæ tunnel into the material, forming burrows which they line with silk.

When articles are in constant use they are seldom or never attacked by these moths; were eggs to be laid upon them, they would be brushed or knocked off before hatching time. Stored and seldom-used garments should have every care. Camphor, naphthalene, and pepper, freely dusted upon blankets, etc., before they are put away, will be avoided by clothes moths seeking suitable spots to deposit their eggs. Such measures, however, are absolutely useless when once the eggs are laid, for neither they nor the larvæ are killed by these substances. Goods which have been attacked should be thoroughly beaten and then sprayed with pure benzine, remembering the while that this substance is highly inflammable.

Hymenoptera

This order is not well represented in the household; bees and wasps often enter the open window, but can hardly be considered as house-dwellers. Ants, however, frequently take up their residence in man's abode. The true house ant is the little red species, known as *Monomorium pharaonis*, L. The little red ant measures about one-sixteenth of an inch in length and is of a yellowish-red colour. Its nests are made

under floor-boards, in walls, or any convenient and apparently permanent situation which will provide sufficient shelter. Unlike all the insects which we have thus far considered, the ants dwell in colonies composed of a queen, males, and workers. The duty of the queen is to lay eggs and so to maintain the population of the colony. The males have served their purpose in life after mating with a queen. The workers, which are really functionless females, feed the queen, tend her eggs, build her nest, and carry out the hundred and one duties necessary for the upkeep of the busy community. Volumes have been written concerning these interesting insects, they have been lauded as models of industry, their intelligence has been considered to be of no mean order. Mark Twain, in a priceless natural-history chapter in his *Tramp Abroad*, is evidently not so impressed as some other observers have been. Speaking of the ant, he says: "During many summers, now, I have watched him, when I ought to have been in better business, and I have not yet come across a living ant that seemed to have any more sense than a dead one. . . . I admit he has industry, of course; he is the hardest-working creature in the world,—when anybody is looking,—but his leatherheadedness is the point I make against him. He goes out foraging, he makes a capture, and then what does he do? Go home? No,—he goes anywhere but home. He doesn't know where home is. His home may be only three feet away,—no matter, he can't find it. He makes his capture, as I have said; it is generally something which can be of no sort of use

to himself or anybody else; it is usually seven times bigger than it ought to be; he hunts out the awkwardest place to take hold of it; he lifts it bodily up into the air by main force, and starts; not toward home, but in the opposite direction; not calmly and wisely, but with a frantic haste which is wasteful of his strength; he fetches up against a pebble, and instead of going round it, he climbs over it backwards, dragging his booty after him, tumbles down on the other side, jumps up in a passion, kicks the dust off his clothes, moistens his hands, grabs his property viciously, yanks it this way, then that, shoves it ahead of him a moment, turns tail and lugs it after him a moment, gets madder, then presently hoists it into the air and goes tearing away in an entirely new direction; comes to a weed; it never occurs to him to go round it, he must climb it, dragging his worthless property to the top—which is as bright a thing to do as it would be for me to carry a sack of flour from Heidelberg to Paris by way of Strasburg steeple; when he gets up there he finds that is not the place: takes a cursory glance at the scenery and either climbs down again or tumbles down, and starts off once more—as usual in a new direction. At the end of half an hour he fetches up within six inches of the place he started from and lays his burden down. . . . After continuing this charmingly aimless work for some time and meeting another ant and fighting him about nothing, each starts off in a different direction to see if he can't find an old nail or something else that is heavy enough to afford entertainment and

at the same time valueless enough to make an ant want to own it."

Whatever may be the intellectual capacity of the individual ant, there is little doubt that as a community these insects exhibit considerable resourcefulness. In the house, the red ant feeds upon all kinds of sweet substances, swarming over them in incredible numbers. On the credit side we may add that these ants are inveterate enemies of bed-bugs.

It is always difficult to rid a dwelling of these insects, for little good will be done till the nests are destroyed. As they are often in very inaccessible places, their destruction is not easy. When found, paraffin or boiling water may be poured upon them or they may be fumigated with carbon bisulphide when feasible. Large numbers may be trapped by putting down pieces of sponge soaked in sweetened water. These traps should be periodically thrown into boiling water to kill the ants which have entered them.

Coleoptera

Many beetles are obnoxious visitors in houses and their activities are varied. The furniture beetles are responsible for a considerable amount of damage, and it may be well to consider one or two examples.

The worst offenders are the Death-watch, *Xestobium tessellatum*, F., and its near ally *Anobium domesticum*, Four. (fig. 34), also various species of the genus *Lyctus*.

The damage done by all these insects consists in tunnelling into the woodwork of floors, beams, and furniture. Externally, their presence may be detected

by the fact that the wood is pierced with a number of shot-holes, from which exudes a quantity of finely powdered wood. Internally, the wood may be so eaten away that it is practically reduced to powder. Old, well-seasoned wood is more liable to attack than younger material.

The Death-watch, whose life-history we may take as being typical of the beetles with similar habits, is larger than *domesticum* and the *Lyctidæ*. As a consequence, it is capable of greater destructiveness. A word or two concerning its popular name may not be out of place. These beetles have the peculiar habit of making a clear, tapping or ticking noise, which in former and less sophisticated times was said to portend death. These tappings are repeated over and over again at regular intervals and are said to be made by the insects striking their jaws against the sides of their burrows. Nearly fifty years ago an observer who, by tapping with a pencil on a box in which he had some captive beetles, made them respond to his signals, wrote: "Raising themselves on their anterior legs, they commenced bobbing their heads up and down rapidly, tapping with their mandibles on the bottom of the box. This performance I could elicit almost at pleasure; the number of taps varied from four to five—usually five are given. The insects have kept on repeating their love-call at intervals throughout the day. I fancy they are a couple of males. After inciting them to tap once or twice they become restless and run about the box, occasionally stopping as if listening for a

repetition of the sound; a few taps with the pencil sets them off again."

Tessellatum is nearly half an inch in length, of a general reddish-brown colour, with a patch of white hairs on the thorax and similar patches on the base and apex of the elytra. As we have said, the beetles tunnel in wood and in the tunnels the females deposit their eggs. When the larvæ emerge, they tunnel in all directions, feeding all the time on the dry wood, which their strong mandibles are well adapted for cutting. When fully fed, the larvæ retire to the end of their tunnels, where they scoop out a small cell in which to pupate. The adults which come from the pupæ frequently leave the tunnels and seek another section of wood for feeding and breeding purposes.

In many situations, these insects are by no means easily eradicated. In the case of furniture that is of little value, if the beetles are numerous, it is better to destroy the whole article at once rather than run the risk of the pests spreading to other woodwork. Often an attack only affects a small portion of some piece of furniture and a fresh panel or board, as the case may be, can be fitted. Small articles may be steamed with advantage or baked for several hours; both of these measures will destroy the insects. Should none of these methods be feasible, benzine may be injected into the tunnels and will kill such insects as it reaches.

Diptera

No household insects are more familiar than house-flies, in the wide sense. The true house-fly, *Musca domestica*, L., however, is frequently confounded with other house-frequenting flies, and many a housewife who would indignantly repudiate the suggestion that she did not know a house-fly when she saw one, would have considerable difficulty in distinguishing *Musca domestica* from certain other flies which frequent dwelling-houses. In medical circles this insect has come into the limelight of recent years. That it was a mild form of wickedness to kill a house-fly, many of us were taught in our childhood; now "Kill that fly!" is a catch phrase which has spread over two continents. We deal with flies as disease-carriers in our concluding chapter, so there is no need to dwell on the matter here.

The common house-fly measures about a quarter of an inch in length; it is of a greenish-grey colour, with four dark stripes on the thorax. The yellowish abdomen has a median dark stripe and a dark apex. The head is furnished with three simple eyes, arranged in a triangle, and a pair of compound eyes, each composed of about four thousand facets. The males may be distinguished from the females by the fact that in the former, the compound eyes are close together, whilst in the latter, there is a distinct space between these eyes. The mouth parts of this insect are solely suctorial; there is no provision for biting or piercing its food or the skin of mankind. People

who aver that they have been bitten by house-flies are the victims of their imagination, or have confused this insect with some other. The proboscis, through which the fly obtains its food, is a modified, elongated mouth, terminated by a pair of soft lips forming a heart-shaped structure, in the centre of which is the aperture through which food passes. Liquid food alone can be taken up by the fly; when such a substance as sugar is eaten, the fly pours its saliva upon it till some is dissolved and in a condition to be absorbed. The foot of the house-fly is provided with a pair of claws, useful for climbing curtains and similar articles. It is also provided with a pair of suckers, known as pulvilli. Each pulvillus is covered with innumerable, minute hairs, each one of which secretes a sticky liquid, with the result that the fly can walk up window-panes or upside down on the ceiling if necessary.

The adult flies are most active from June to October. Every female deposits five or six batches of eggs, each containing from one hundred to one hundred and fifty oval, pearly-white eggs, about one-twenty-fifth of an inch in length. Stable manure is the most favoured material on which to oviposit, but, failing animal excrement, decaying vegetable matter or even the contents of slop pails and spittoons may be selected. Under favourable conditions the egg stage only lasts from eight to twenty-four hours. The segmented, cream-coloured, legless larvæ feed ravenously on their filthy surroundings, moult at the end of the twenty-fourth hour, and again a day later, when they attain

their full growth and measure about half an inch in length (fig. 35). The anterior or head end of the house-fly larva is pointed and provided with a hooked process which is used in locomotion and in tearing up its food. The posterior end is furnished with a pair of eye-like spiracles or breathing pores, and, on the under surface of the sixth and the twelfth segments, there are pads furnished with recurved spines —additional aids to locomotion. When fully fed, the larvæ leave their feeding ground for some drier situation, contract, and change into chestnut-coloured, barrel-shaped puparia, from which the adult flies emerge in from three to four days. The house-fly is remarkably prolific and, as we have shown, its life-cycle is completed in a very short time. Herrick says: "One can hardly realise the enormous numbers that such rapid development is capable of producing. Inside of two months, one female fly can give rise to many millions of progeny. For the purpose of illustration, we will assume that a female fly lays a hundred eggs. If these hatch and all the larvæ come to maturity, about one-half will probably be males and the other half females. Then at the end of the first generation there will be fifty egg-laying females. At this rate, at the end of the eighth generation, there would be produced about 1,875,000,000,000 adults. Of course, in nature, a very large part of these would die and never reach maturity, so that actually one female would probably never produce such an enormous number of individuals. However, under normal conditions tremendous numbers are produced."

In dealing with house-flies, the first consideration is to attack them in their breeding-places, or better, to deprive them of facilities for increasing their kind. In this respect we may add that the fly question will never be satisfactorily answered as long as manure-heaps are allowed to stand for weeks on end in the vicinity of dwelling-houses. The open dustbin, too, is a standing invitation to the house-fly to increase her kind in comfort and without the trouble of straying far afield to find food for her offspring. Every dustbin should be provided with a well-fitting lid; stable manure should be cleared at least twice a week and taken far from human dwellings, or spread thinly on the land in order to dry quickly and thereby become unsuitable as a home for the larvæ. In the house, despite much that has been said and written to the contrary, the old remedies more than hold their own. The sticky fly-paper in its various forms is still as good a remedy as any, and may be supplemented by a saucer containing equal parts of forty per cent. formalin, milk and water, in the centre of which is a piece of bread, on which the flies may settle to feed and simultaneously to be poisoned.

Of the other house-frequenting flies we have only space to consider briefly the Lesser house-fly, *Fannia canicularis*, L., the Cluster-fly, *Pollenia rudis*, F., and the Blue-bottle or Blow-fly, *Calliphora erythrocephala*, Macq.

The lesser house-fly is very often mistaken for a young house-fly; in fact, superficially, it closely

resembles a small specimen of its larger relative. There are many points of difference between the two insects, however. The lesser house-fly has but three dark stripes on its thorax, has a more pointed abdomen, appears earlier in the season, and has a characteristic jerky flight, quite different from the slower, more laboured efforts of the common house-fly.

The female deposits her eggs in material similar to that favoured by the house-fly, and the eggs of the two species are very similar. The larvæ, however, are peculiar (fig. 36). About a quarter of an inch in length, they are flattened and armed with a double row of spines down the back and a similar protection down either side of the body. The pupæ are chestnut-coloured and barrel-shaped.

The cluster-fly is not so truly a household insect as the preceding species; it appears to enter houses only in the autumn. In appearance it is not unlike the house-fly, but is of rather stouter build, of a reddish-grey colour, and its wings overlap when at rest. The insect has earned its popular name from its habit of collecting in clusters in the corners of rooms, behind pictures, etc. It also crawls about living-rooms in a semi-torpid state and, in this state, is easily destroyed. Very little is known of the life-history of this fly, despite the fact that it is exceedingly common. It probably breeds in decaying animal and vegetable matter, after the manner of the house-fly.

The blue-bottle, like the cluster-fly, is only an occasional visitor to houses. It may be distinguished

from the other flies we have described by its metallic blue colour, its heavy build, and its rapid, noisy flight.

Normally, oviposition takes place upon meat, and with that object the fly enters dwellings. Failing meat, the eggs may be deposited on decaying vegetable matter or on excrement. The fly is very prolific, for a single female will deposit as many as six hundred eggs. The larvæ, which are popularly known as gentles, hatch in from eight to twenty-four hours. They are larger than house-fly grubs and have twelve tubercles on the posterior end. In seven days they change into brown puparia and the adults emerge in a fortnight.

Making due allowance for slight differences in habit, these flies may be dealt with in the same manner as house-flies.

Orthoptera

As a household insect *par excellence* the house-fly has a rival in the shape of the Common Cockroach, *Periplaneta orientalis*, L., a member of the family *Blattidæ* and closely related to the grasshoppers and crickets. This familiar insect is popularly known as the black beetle, and, as is so often the case with popular names, it is quite misleading. The insect is dark brown and not black, though some of the older individuals almost attain this colour. It is certainly not a beetle, but here the scientific appellation of the family is at fault, for the Latin word *blatta* signifies a beetle.

The Cockroach is reported to be a native of tropical Asia, and it affords an excellent object-lesson of the manner in which an insect may follow man in his wanderings over the earth and adapt itself to a changed environment. The insect was probably introduced into Europe during the sixteenth century, in ships plying between this country and the East. At first it was only to be met with in seaport towns; now, however, there is hardly a village in the country to which the insect is a stranger, hardly a town in the civilised world where it is unknown. The Common Cockroach is to-day practically cosmopolitan.

Hailing originally from warmer climes than we can show, it is scarcely surprising that the "black beetle" usually installs itself in our kitchens and bakehouses. It selects situations where it can count on a reasonable supply of heat. In habit these insects are nocturnal, hiding, by day, beneath skirting boards, behind boxes—anywhere, in fact, where they may shun the light and keep warm. By night they issue from their hiding-places in droves and seek their food. Garbage and the choicest morsels are equally acceptable to them; food which they cannot eat they soil with their filthy bodies, loading the air, meanwhile, with their characteristic, nauseating odour. Leather, blacking, and even their own kind are devoured in turn, for, should other food fail, they turn cannibal. They are as persistent as the little red ant in seeking the treasures of the larder, and far more repulsive in their activities when they have attained their goal. Their sole redeeming feature appears to be their inveterate

hatred of the bed-bug, which they will rapidly exterminate from a dwelling.

The adults are very variable in size, and some of the larger females attain a length of nearly two inches. The two sexes may be easily distinguished; the males are the smaller and are winged, whilst the larger females possess rudimentary wings at most. The females, too, have the peculiar habit of dragging their abdomens along the ground as they walk; in the healthy male the abdomen is always raised from the ground. The colour of the Cockroach largely depends on its age, becoming darker with the lapse of time. Their flattened, highly polished bodies are well adapted to the habit of entering all manner of cracks and crevices, with the object of hiding by day or seeking food at night.

The life-history of this exceedingly common insect is the subject of a certain amount of controversy among entomologists, mainly with regard to its duration. As is the case with many of the *Orthoptera*, the female deposits her eggs, neatly enclosed in an egg-case. Each purse-like egg-case is approximately bean-shaped, about half an inch long, cream-coloured at first, but turning brown later, and of a horny texture. Its ends are rounded and the upper edge has the appearance of a longitudinal, toothed ridge, but in reality is a slit, kept closed by the elasticity of the material of which it is composed. The eggs within the case are disposed in two alternating rows of eight each, and so arranged that the heads of the larvæ are in the direction of the longitudinal slit.

The outlines of the sixteen eggs may be faintly discerned on the exterior of the egg-case. When the egg-case is full, it is carried about by the female, protruding from her abdomen (fig. 37), for a considerable time, often as long as a week. During this period the insect diligently seeks a suitable hiding-place for her precious burden. Each female is reported to deposit eight or so of these egg-cases in all.

The larvæ hatch within the case and make their way out by pushing aside the elastic walls, leaving their late home in an undamaged condition. The larvæ closely resemble the adults except in size and colour; were it not for their black eyes they would be almost colourless. Precisely how many moults are passed through by these insects is not known. One takes place almost immediately after hatching, another four or five weeks later, and a third at the end of a year. With each moult the larvæ become darker in colour and more like their parents. After the first year, moults take place annually, and, according to some observers, they number seven. Although each moult results in an eventual darkening of colour, the first hours after the old skin has been cast reveal an insect which is nearly white. At the penultimate moult the rudiments of wings appear and the insect has become a nymph. There is no pupal stage, for, in the Orthoptera, metamorphosis is incomplete. The final moult produces the perfect insect—the winged male or the wingless female, though the sexes may be distinguished for the first time in the nymphal stage.

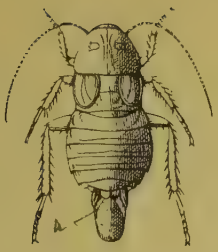


FIG. 37. COCKROACH. *Periplaneta orientalis*, L.
FEMALE ABOUT TO DEPOSIT EGG CASE, *a*.

FIG. 38. MEDITERRANEAN FLOUR MOTH, *Ephestia kühniella*, ZELL.
a and b. ADULT FLYING AND RESTING; *c and f*. LAVA, LATERAL AND DORSAL VIEWS; *e*. SEGMENTS OF LAVA MAGNIFIED; *d*. PUPA

The control of these insects is by no means easy. Where feasible, fumigation with hydrocyanic acid gas or carbon bisulphide is the surest means of eradication. Traps, which may be bought at any ironmonger's, baited with stale beer will capture thousands of these pests, but however many are trapped there always seem to be more to take their places. Powdered borax, dusted freely and frequently into their haunts, will work wonders in the extermination of "black beetles."

CHAPTER IX

WAREHOUSE PESTS

We have reviewed the life-histories of a few insects which pay unwelcome visits to our living-rooms, or dwell therein. The majority of such insects dwell in proximity to mankind because, by doing so, they can obtain food in abundance and without undue trouble. It is obvious, therefore, that in storerooms and warehouses where food, skins, drugs, and similar commodities are kept, other insect enemies are likely to be encountered. Many of these pests find their way into houses; in fact, the question of their presence or absence in any given situation, depends on whether the food they require is there or not.

Lepidoptera

Two common pests of stored cereals such as flour and meal are the Mediterranean Flour moth, *Ephestia kühniella*, Zell. (fig. 38), and the Meal moth, *Pyràlis farinalis*, L. Both belong to the family *Pyralidæ*, and are responsible for a considerable amount of damage.

The Mediterranean Flour moth has only been known as a granary pest for a little more than a quarter of a century. The adults measure about three-quarters of an inch in wing span. The fore

wings are dark grey, marked with two darker, wavy, transverse lines and a few dark dots, the edges are fringed with long, hair-like scales; the silver-grey hind wings are similarly fringed. The female may oviposit at any season of the year. Each individual deposits about two hundred and fifty very minute, oval, white eggs, usually on the sacking or packing in which the cereals are contained. In about a week the larvæ emerge and, as may be surmised from the size of the eggs, they are exceedingly minute. They feed upon flour and similar substances, spinning silken threads the while, with the result that particles of the food material become so matted together as to be useless for human consumption. In about eight weeks or rather more the larvæ are fully fed; they then measure about half an inch in length and are of a pinkish-white colour with brown heads; they spin silken cocoons on the sides of the vessel or sack in which their food is contained. Within this cocoon they pupate, and in about a fortnight the adults emerge.

These insects are spread from place to place not only in flour itself but in sacking, etc., from mills. Where a small quantity of food material is found to be infested, the best course is to destroy the whole, thoroughly clean the vessel in which the infested material has been kept, and start afresh. In mills where large quantities must be dealt with, the remedy is not so easy. In such cases fumigation with hydrocyanic acid gas or carbon bisulphide should be tried.

The Meal moth, or rather its larva, is not so particular in its diet as its relative, for, in addition to ground cereals, it will devour whole grain, straw, etc. In wing span the adults measure nearly an inch, and the insect is of heavier build than the Mediterranean Flour moth. Each fore wing is marked with two wavy, transverse, white lines; in the space between is a light-brown area, whilst at the apex and base of the wing there is a chocolate-coloured patch. The hind wings are light brown, each marked with two white lines, continuations of those on the fore wings.

There is a considerable amount of discrepancy in the accounts of the life-history of this pest. This much is known, however. The female deposits her eggs on or near the food material. The larvæ which emerge have red-brown heads and are of a pinkish white colour. They construct cases of their food material, after the manner of the clothes moths, and within these cases they dwell till fully fed. When they are ready for pupation, they forsake their shelters and spin silken cocoons in which to pupate.

The same remedies may be used as were recommended for the Flour moth.

The Cloaked Knot Horn, sometimes called the Indian Meal moth, *Plŏdia interpunctella*, L. (fig. 39), is a pest of stored goods, with habits very similar to those of the Mediterranean Flour moth. In addition to flour and similar products, the larvæ infest raisins, prunes, currants, dried apples, peaches and cherries, biscuits, and various seeds.

The adults measure nearly three-quarters of an inch

in wing span. The fore wings are brown, marked with irregular black patches at the apex, shading off to cream at the base; the fringed hind wings are grey. The life-history is practically identical, in important details at any rate, with that of the Mediterranean Flour moth. The larvæ have the same habit of spinning their food particles together by a silken thread. The same methods of control may be used for the two species.

The Angoumois Grain moth, *Sitotroga cerealella*, Ol., has habits which differ in many important respects from those of the three species we have already considered. The insect derives its name from the French province of Angoumois, where it was early recorded as a pest of stored cereals. Unlike the preceding species, the larvæ of this moth attack whole grain instead of milled cereals.

The adults resemble large clothes moths; their wings span about half an inch and are pale straw-coloured, mottled with very dark brown or black. Both fore and hind wings are prominently fringed. The females deposit their elongated eggs on grain; when newly laid they are white, but they rapidly change to a pinkish shade. In less than a week the larvæ emerge and, at once, bore into the cereal on which the eggs have been laid. Their procedure at this stage seems to depend somewhat on the nature of their food. In the case of a small grain such as wheat, only one larva enters each one, but a maize grain, for instance, may be inhabited by two larvæ.

In about a month the larva is full-fed, cream-

coloured, and somewhat stouter at the head end than posteriorly. During all this time the larvæ never leave the grains which they entered in their early stages. Just before pupation, however, they eat their way almost through the pericarp of the grain within which pupation takes place. When the moths emerge, it is only necessary for them to break through the very delicate layer of pericarp, to be free.

The insects are difficult to eradicate owing to the habits of the larvæ. Feeding within grain, they are not easily reached by insecticides. When small quantities of grain are attacked, it may be wise to sacrifice the whole. In larger and more valuable stores fumigation with carbon bisulphide is as good a remedy as any. Best of all, however, is to keep the cereal and its pests at a high temperature for several hours; this treatment will kill eggs, larvæ, pupæ, and adults. The remedy, however, is not feasible in all cases and requires special apparatus.

Coleoptera

The beetle pests of grain and milled cereals are represented by a considerable number of species. Among the commoner of these may be mentioned the Meal worms—the Common Meal worm, *Tenebrio molitor*, L. (fig. 40), and the Dark Meal worm, *Tenebrio obscurus*, F., members of the family *Tenebrionidæ*. This insect was mentioned so long ago as 1634 by Thomas Mouffet; its scientific name is strikingly apt, for it means a miller who shuns the light. The

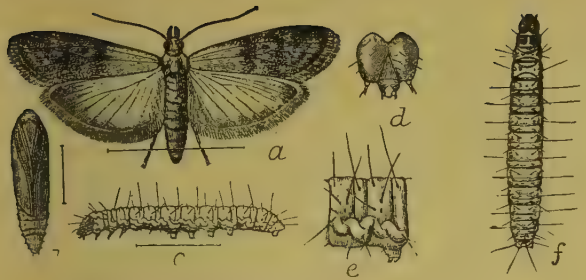


FIG. 39. INDIAN MEAL MOTH, *Plodia interpunctella*, L. *a*. ADULT; *b*. PUPA; *c and f*. LATERAL AND DORSAL VIEWS OF LARVA; *d*. HEAD; *and e*. SEGMENTS OF LARVA

FIG. 40.
MEAL WORM,
Tenebrio molitor, L

FIG. 41. CADELLE,
Tenebroides mauritanicus, L.

beetles appear to feed solely on milled cereals of various kinds. The adults are about half an inch in length and of a shining black colour in the case of *molitor*, and dull black in *obscurus*. The female deposits her white, bean-shaped eggs on flour or a like substance, either singly or in groups. Each egg or group is covered with a sticky substance, with the result that it quickly becomes covered with the material in which it is deposited. In about a fortnight the larvæ appear, and at once begin to feed upon their surroundings. When freshly emerged, they are white in colour, but, as they grow older, they turn yellow and waxen-looking. They are about an inch in length when fully fed, and almost cylindrical; in fact, they bear considerable resemblance to wireworms. The larval period extends over at least three months, during which time the insects feed voraciously and undergo at least a dozen moults; then a change takes place and the yellow larva becomes a cream-coloured, rather spinous pupa. Two weeks later the adult beetles appear. Owing to the length of the larval stage, there is only one generation a year.

Although this insect is commonly regarded as a pest—indeed, in the usual course it is capable of doing much harm—it is, nevertheless, an article of commerce of some importance. The cult of bird-keeping has increased enormously in recent years; many of these feathered pets require a constant supply of living insects, and the Meal worm larvæ, willy nilly, have filled the want. Meal worms are bred in large

quantities solely to provide food for insectivorous birds and a few other pets such as chameleons. At every bird-shop one may buy an ounce of Meal worms, as one would buy an ounce of tobacco at one's tobacconist's.

When these insects infest the flour-bin, they may be killed by fumigation with carbon bisulphide.

Two flour beetles belonging to the same family as the Meal worm are the Confused Flour beetle, *Tribólium confusum*, Duv., and the Rust-coloured Flour beetle, *Tribolium castaneum*, Herbst; both occur in Britain, but the latter is the commoner. These two species somewhat resemble a miniature meal worm, and so closely resemble one another that it requires an expert to separate them. The adults of both species measure about a sixth of an inch in length and are of a chestnut-brown colour; their somewhat flattened bodies have head, thorax, and wing-cases marked with minute punctures. In *confusum*, the joints of the antennæ gradually increase in size from base to apex, whilst, in *castaneum*, only the last few joints are larger than those at the centre and base.

These beetles feed upon practically all kinds of prepared cereals and, in addition, they do not disdain ginger, baking powder, cayenne pepper, orris root, snuff, and dried beans. The females deposit their small white eggs, either in the future larval food, or in the cracks and crevices of the vessel in which it is contained. The larvæ, when they first emerge, about a week after the eggs are laid, are white in colour, but later they become darker, and resemble

miniature meal worms. They feed for about a month and, while doing so, they ball their food material together into hard lumps, within which the insects may be found in all stages of development. Pupation lasts little more than a week, so that the whole life-cycle is completed in five weeks or so, and there are several generations in a year.

Fumigation with carbon bisulphide is the best remedy for this pest, though it is difficult to reach the insects within the balled masses of food material. In addition, the bins in which the infested food has been stored should be well scoured with boiling water, for it is in such places that the insects hide and deposit their eggs.

A beetle of grain-loving propensities which cannot be wholly classed as a pest is the Cadelle, *Tenebroides mauritanicus*, L. (fig. 41). Our reason for making some apology for placing the Cadelle among our insect enemies is that its larvæ, in addition to being vegetarians, are also predaceous, and, among their victims, the larvæ of the two injurious species of *Tribolium* are often numbered. The name Cadelle is of French origin and has the merit of almost universal acceptance.

The adults are rather less than half an inch in length, of a shining black colour. The wing-cases are deeply furrowed; between them and the punctured head and thorax there is a deep constriction—the insect has a decided waist. Small, white, elongated eggs are laid by the females amongst the material which is to form the food of the larvæ, cereals of

one kind and another evidently being favoured. In about a fortnight, the curious-looking larvæ emerge, and they appear to feed for eight or nine months. When fully fed they are pinkish white. The head and its adjacent segment, also the apical portion of the last segment, are chestnut-coloured. From the last-mentioned brown patch, two prominent hooks project. Before changing into pupæ, the larvæ burrow into any available piece of wood, within which they form a cell and pupate. In a month or six weeks the white pupæ give rise to the adults.

The remedies suggested for other grain-eating beetles may be used for this insect.

The Saw-toothed Grain beetle, *Silvanus surinamensis*, L. (fig. 42), sometimes erroneously called a weevil, is a cosmopolitan species and is liable to be met with in any granary. Not only does it attack cereals of all kinds, but it also damages starch, ginger, tobacco, mustard, dried apples and peaches. The beetle is so named because, on either margin of the somewhat elongated, doubly furrowed thorax, there are a number of teeth which give the edge a saw-like appearance. The beetles are minute, not exceeding a tenth of an inch in length. Reddish brown in colour, somewhat flattened, with head, thorax, and wing-cases punctured, the last-named also showing a number of longitudinal ridges. When once this little pest has gained entrance to the warehouse, it increases with alarming rapidity. It is probable that the life-cycle is completed in about a month, so that there are several generations in a year.

The larvæ of this pest may be easily recognised by the fact that they are somewhat flattened and by the presence of a number of hardened areas along the back, one on each segment. The white pupa is formed in the food material. Remedies as for other insects of similar habit.

The family *Curculionidæ* supplies two of the worst pests of cereals in the shape of the Granary weevil, *Calandra granaria*, L., and the Rice weevil, *Calandra oryzæ*, L. (fig. 43). The former is the commoner, the latter the more destructive.

The adults are very similar to one another. Both species measure about an eighth of an inch in length; *granaria* is bright brown and *oryzæ*, dull brown. The wing-cases of both beetles are furrowed with longitudinal grooves, and those of *oryzæ* bear four reddish-brown patches.

The Granary weevil has long been known as a pest. As a result of frequenting the stores which man has gathered together, and having no need to use its wings in search of food, it has lost their use. The female, which is provided with a gnawing mouth at the end of its snout-like rostrum, bites a minute hole in a grain of wheat, maize, or the like, and therein deposits a single egg. The legless, fleshy, cream-coloured larva lives within the grain and later turns into a white pupa. The females are very prolific; a single pair of these insects is capable of producing more than six thousand descendants in a year. Not only are the larvæ of the Granary weevil injurious, but the adults also eat away the interior of grains

and enter the portions they have hollowed out, for shelter.

The Rice weevil is a native of Asia, and has been so named because it first came into prominence as a pest of rice. In habit it agrees closely with *granaria*, but, when the adults emerge from the pupæ, instead of at once forsaking the grain in which the pupa was concealed, they stay within their natural shelter for some days, feeding the while on the portions of the kernel left undamaged by the larva.

For these beetles also, the remedies already recommended may be used.

Two species of Leather beetles, as the members of the family *Dermestidæ* are popularly called, are liable to cause trouble in warehouses where animal products, such as ham and bacon, are stored. The species are the Larder beetle, *Dermestes lardarius*, L. (fig. 44), and its relative *Dermestes vulpinus*, F. In habits these beetles are practically identical. The adults of both species are about a third of an inch long, dark brown in colour, and oval in outline. A yellowish-brown band runs right across the bases of the wing-cases in *lardarius*; whilst, though *vulpinus* has no similar band, it has a white patch on each side of the thorax.

Eggs are deposited by the females, either on or near suitable larval food. This, it may be added, is exceedingly variable; ham and bacon have already been mentioned, but skins, feathers, horns, hoofs, beeswax, and hair are all fit food for these insects. The larvæ, which measure about half an inch in length, are quite unlike those of any of the pests we

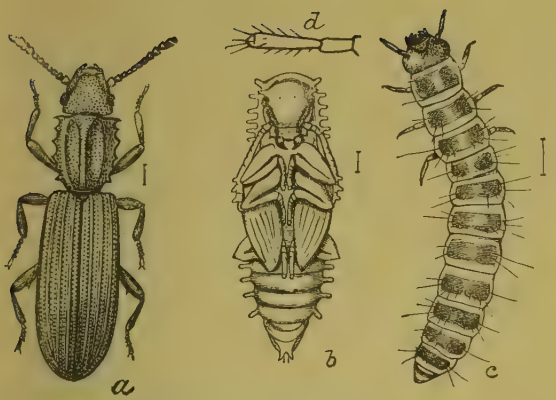


FIG. 42. SAW-TOOTHED GRAIN BEETLE, *Silvanus surinamensis*, L. *a.* ADULT; *b.* PUPA; *c.* LARVA WITH MAGNIFIED ANTENNA *d.*

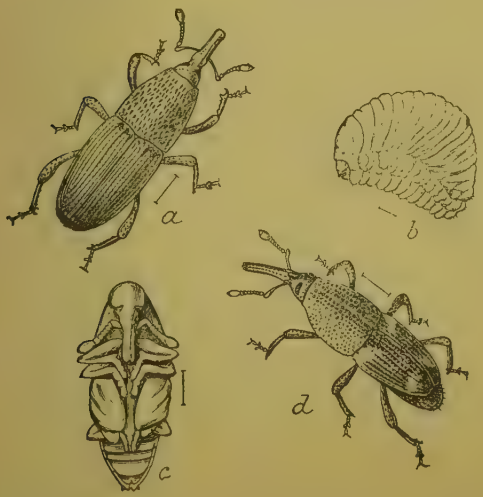


FIG. 43. WEEVILS AND GRAIN WEEVIL, *Calandra granaria*, L. *b.* LARVA; *c.* PUPA; *d.* RICE WEEVIL, *Calandra oryzae*, L

have so far considered; they are very hairy. When newly emerged, feeding proceeds on the outside of the substance selected for sustenance. Later, the larvæ tunnel into their food, especially into the fatty parts, there to pupate. Several points in the life-histories of these beetles require elucidation; they are, however, prolific and there are several generations in a year.

Hams, etc., should be so stored that the beetles cannot reach them; this may be accomplished by the aid of paper bags securely fastened. Portions of any preserved meat attacked by the larvæ should be cut out and burned. Storerooms, where Leather beetles are known to exist, should be cleared of edibles if possible, and well fumigated with carbon bisulphide or with hydrocyanic acid gas. Very many of the beetles may be caught by hand and killed.

The little insect which has been called the Red-legged Ham beetle, *Necrobia rufipes*, F., is not such a serious pest of preserved meats as the two insects we have just described. It appears in considerable numbers, however, from time to time, so is worthy of a place among our insect enemies. About a fifth of an inch in length, of a light metallic blue, with red legs, this beetle is easily recognised. It belongs to the family *Cleridæ*.

The female lays her eggs, during the summer, on some kind of preserved meat, ham for preference. The eggs are very small and cream-coloured. The larvæ are white, with brown heads when they first appear; they eat their way at once into the fat of their food material. They are fully fed in a short

time and then measure about half an inch in length; they have also darkened in colour considerably since their emergence. Pupation may take place either in the food material or in its vicinity. A cocoon is made from the dried saliva of the larva; it has the appearance and consistency of paper. There are probably several broods in a year.

Where the presence of this insect is suspected or discovered, precautions should be taken to prevent hams, etc., from being attacked. When the beetles have begun work on any kind of preserved meat, it will usually be found that their depredations are more or less superficial and the damaged parts can easily be cut away. In bad cases, the remedies advised for Leather beetles should be tried.

The Cigarette beetle, *Lasioderma serricorne*, F. (fig. 45), is, perhaps, unfairly treated in being placed amongst British injurious insects. Though it could hardly be termed common in this country, it is, on the other hand, by no means rare, in fact it is cosmopolitan. Amongst the substances on which it feeds are raisins, rhubarb, cayenne pepper, rice, ginger, dried fish, upholstery, ergot, turmeric, books, cane-work, gun wads, liquorice, saffron, belladonna, and pyrethrum powder. It is chiefly as a pest to tobacco, in various forms, however, that this insect has become notorious. The greatest damage is done to the wrappers of cigars and cigarettes, through which the insect eats small holes, so that the smoke will not draw.

The adult Cigarette beetles are about a sixteenth of an inch in length, of a reddish-brown colour and

FIG. 44.
LARDER BEETLE.
Dermestes lardarius, L

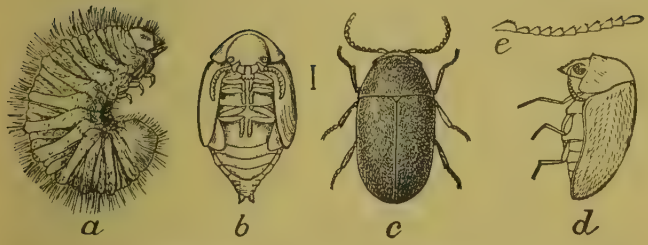


FIG. 45. CIGARETTE BEETLE, *Lasioderma serricorne*, F. *a*. LARVA; *b*. PUPA; *c and d*. ADULT VIEWED DORSALLY AND LATERALLY; *e*. ITS ANTENNA MAGNIFIED

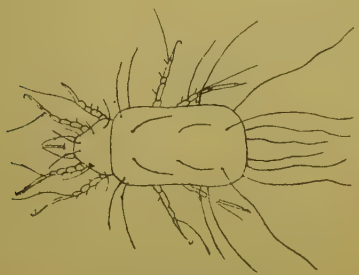


FIG. 46. CHEESE MITE,
Tyroglyphus longior,
GERVAIS

somewhat hairy. The female deposits her eggs singly in the crevices of a tobacco leaf, usually along the midrib; oviposition, also, often takes place within the open tip of a cigar or cigarette, where the whitish, tough-shelled eggs are most difficult to detect. In a week or rather more, the cream-coloured, somewhat hairy larvæ emerge and begin to devour the tobacco leaf. In connection with the larval feeding it is interesting to note that the size of the adults into which the larvæ eventually develop, depends not only on the quantity but on the quality of the tobacco eaten in the immature stage. By experiment, it has been shown that beetles, obtained from selected cigars, were often double the size of those from low-grade tobacco. The female is a connoisseur, for she will oviposit on Claro cigars by preference to Maduras, on expensive Turkish cigarette tobacco rather than on material of poorer quality. This choice on the part of the mother beetle is solely with a view to the well-being of her offspring, for the adults themselves do no actual damage. The larval feeding period extends over about sixty days and, at the end of this time, pupation takes place with a silken cocoon, which is usually covered with particles of the larval food material.

Goods infested by this insect may be destroyed, if small in quantity. More valuable stock may be subjected to fumigation with carbon bisulphide. Expensive plant, designed to destroy this insect by electricity, has been set up in America, but the results were not promising.

Diptera

The Cheese skipper, *Piophĭla casei*, L., is a somewhat unpleasant frequenter of our storerooms. The skipper proper is the larva of a small, glistening black fly about half an inch in wing span. The fly is cosmopolitan and attacks not only cheese, but meats of various kinds. It always shows a decided preference for the richest of food, and would attack Stilton rather than Dutch cheese, or pork before beef.

The female deposits about thirty slender, oblong, slightly curved, white eggs, either in compact clusters of five to fifteen or, on occasion, they are scattered singly. In about thirty-six hours, small, white, cylindrical, legless maggots, or skippers, emerge, and at once begin to feed. They somewhat resemble the grubs of the house-fly, being pointed at the head end and truncate posteriorly, where are situated a pair of stigmata or breathing organs and a pair of fleshy filaments. When fully grown, which occurs in about a week, the larvæ measure about a third of an inch in length. They frequently give a display of the curious habit which has earned them their name. By bringing together the two extremities of their bodies and then straightening them out rapidly, just as a short piece of watch-spring, bent from the ends, would straighten when released, they can jump to a height of three or four inches. After full growth has been attained the larvæ feed for another week, then, forsaking their food material, they seek out some dry spot, contract, turn yellow,

and gradually change into golden-brown pupæ, whence the adults emerge in about ten days. In normal circumstances, the life-cycle is completed in rather more than three weeks; unfavourable conditions, such as lack of food or low temperature or both, may cause the period to be doubled.

Again in this case, it is better and easier to keep the pests from cheeses, hams, etc., than to eradicate them after they have entered the storeroom. Infested portions of cheese should be cut out and destroyed. After a thorough cleaning, the room in which infested food has been kept should be fumigated with sulphur.

Mites

The Cheese mites, *Tyroglyphus longior*, Gervais (fig. 46), and *Tyroglyphus siro*, L., are very well-known pests, and their life-history is most remarkable. They have been known from the earliest times and, by Aristotle, they were thought to be the smallest of living creatures. Their small size and varied diet—they devour ham, flour, and various stored foods in addition to cheese—coupled with a fecundity that is almost incredible, has resulted in their attaining an almost world-wide distribution. The mites may often be found infesting the same food; they are very minute, nearly colourless, eight-legged creatures and, therefore, are not insects. *Longior* is larger, more active, and more elongated than *siro*; it is also clothed with longer hairs.

The females increase their kind haphazard, amongst the substance on which they are feeding. The six-

legged larvæ only attain their full number of legs after moulting. Another stage may arise during the life-cycle; it is called the hypopus, and is so unlike the adults that for a long time it was considered to be a mite of another genus.

The most interesting question in the life-history of a Cheese mite is, What becomes of the mites when all the cheese is eaten? A study of the mites during the summer months will not be much help. Their powers of locomotion are feeble, and their bodies are soft and easily damaged, so that it is highly improbable that they will walk from one cheese to another. When no food is at hand, the young mites and the old ones die off and considerately leave the field clear for the more vigorous, middle-aged individuals. The survivors completely change their form by acquiring a hard, brown protective covering, into which their legs can be drawn, and, at the same time, their existence without food can be almost indefinitely prolonged. This is known as the hypopus stage. As everything comes to him who waits, sooner or later a mouse or a house-fly or perhaps a cockroach comes along in quest of food, the hypopus shoots out its legs and eagerly seizes some convenient hair, to which it clings, till it is carried to a spot where suitable food is at hand; then, relaxing its hold, it throws off its horny coat and begins life afresh.

Cheese attacked by these creatures is rapidly reduced to a crumbling, seething mass of mites, their cast skins and excreta. The work of eradication is by no means easy. A thorough cleaning of the storeroom

should be carried out as a preliminary, followed by thorough fumigation with sulphur. All infested portions of cheese, ham, etc., should be destroyed, but the mites are so small that it is difficult to make certain that all are eradicated.

The Flour mite, *Tyroglyphus farinæ*, de G. (fig. 47), is very similar in habits to the Cheese mites; it lives, however, in flour.

CHAPTER X

INSECTS INJURIOUS AND ANNOYING TO MAN

THE insects which are found upon man's person may be divided into two classes: those which merely cause annoyance such as gnats, bees, and wasps, and those which may bring disease in their train—house-flies, lice, and bed-bugs. These two classes may again be subdivided into insects which suck man's blood and those which do damage by other means. Many are so-called household insects—the house-fly, flea, and bed-bug are cases in point; others are creatures of the open air, gnats, midges, etc.

LEPIDOPTERA

Butterflies and moths are, in the main, perfectly harmless as regards man himself. The only injury that is caused to human beings by any members of the order, results from the action of the hairs of certain larvæ. As is well known, many lepidopterous larvæ are decidedly hairy; it is perhaps not so well known that the hairs of some of these insects are capable of setting up intense irritation in the human skin. One of the worst offenders in this respect is the Brown-tail moth, *Euproctis chrysorrhœa*, L. The larva is clothed with long ordinary hairs and shorter, stouter poison

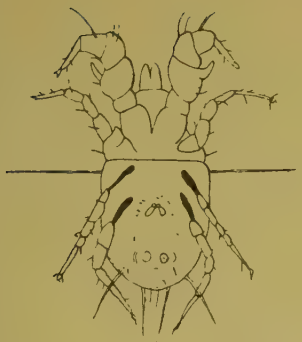


FIG. 47. FLOUR MITE, *Tyroglyphus farinae*, DE G.

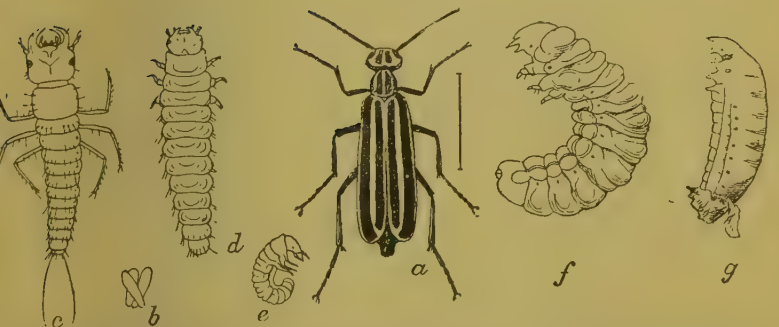


FIG. 48. BLISTER BEETLE. *a*. FEMALE; *b*. EGGS; *c*. FIRST STAGE LARVA; *d* & *e*. SECOND STAGE LARVA; *f*. THIRD STAGE LARVA; *g*. FINAL LARVAL STAGE

FIG. 49. LARVA OF HUMAN FLEA. *Pulex irritans*, L

hairs; the latter are responsible for the irritation. Each hair is very sharply pointed, barbed, and hollow; it probably contains some irritant which acts on the blood.

In America this insect has attracted more attention than in this country. There it became a serious forestry pest, and entomologists who worked in the experiment stations, devoted to the control of the insect, suffered severely from "brown-tail rash." Herrick, in describing the symptoms, says: "Wherever these caterpillars are in abundance in the vicinity of human beings, a disease known as 'brown-tail rash' appears. The disease affects mostly the neck, hands, and face, although it may break out all over the body. It begins with an intense irritation, followed by eruption resembling eczema, each eruption with a watery blister on top. Sometimes large pustules containing pus form on the skin. The first attack usually lasts a week or ten days. One can, however, be poisoned as often as the caterpillars strike the skin. The trouble is said to be much worse than that caused by poison ivy, and harder to eradicate. It does not, except possibly in rare cases, when combined with other troubles, terminate fatally. It seems to be especially severe on persons suffering from dropsy and tuberculosis. The disease is caused by the nettling hairs of the caterpillars penetrating the skin. It may be contracted simply by coming in the vicinity of the caterpillars, although not in actual contact with them, for the fine hairs are blown everywhere by the wind. Clothing hung out of doors near the larvæ

becomes covered with the hairs, which may nettle the whole body when the garments are worn."

The following lotion is said to give considerable relief in cases of rash, caused by irritating hairs: menthol 10 grains, zinc oxide 2 drams, lime water 8 oz., carbolic acid 15 drops.

Coleoptera

Beetles may be ranged with the Lepidoptera as far as their damage to mankind himself is concerned. Maybe some of the *Meloidæ* or Blister beetles, in the shape of such species as *Lytta vesicatoria*, L., might be dubbed annoying. These beetles contain a powerful blistering agent, which is still used medicinally, but their greatest interest, from an entomological point of view, lies in their extraordinary life-histories. They go through a hypermetamorphosis (fig. 48).

The female beetle deposits her eggs near a bee's nest or upon some plant, according to her species, and from them arise very active larvæ, which, as the case may be, either remain near the bee's nest or frequent flowers. Sooner or later a female bee comes along, the alert larva fastens itself to the hairy body of its host and is carried thereon to the nest. When the bee deposits an egg in the honey which she has stored up for her offspring, the beetle larva springs on to it and is, of course, sealed up in the honeycomb cell by the mother bee. The bee's egg forms at once boat and nutriment for the beetle larva; it could not survive immersion in the honey. For about a week it feeds on the contents of the egg, then casts its skin

and becomes a fleshy, almost legless grub, well adapted to living in and feeding on the honey. When its second food-supply is all devoured another moult takes place and the larva becomes quite legless, very similar to the grub of the bee; in this stage it requires no nourishment, which is a good thing, for none is available. Later, the adult beetle emerges from its pupa and the honeycomb. Bees of the genus *Anthophora* appear to be specially sought by the larvæ; another genus of *Meloidæ*, however, frequents locusts' nests. Pages could be and have been written about this marvellous insect drama. That any of the beetles attain maturity is little short of incredible. How remote their chances are may be realised by considering for a moment that the larval beetle, to achieve its object, must become attached to the female of one species of bee, and one species only. Any bee will not supply the needs of any larva, for each beetle has its special host. No wonder that each female of a species of these beetles is said to deposit ten thousand eggs, for very, very many of the larvæ can never reach their haven.

Hymenoptera

One of the classes into which this order is divided is known as the Aculeata. Aculeate Hymenoptera are membranous-winged insects whose females are provided with ovipositors designed, not only for egg-laying, but for stinging. It is hardly necessary to add that the females alone sting. Amongst the British Aculeate Hymenoptera, bees, wasps, and hornets are

numbered. In all essentials, the "stings" of these insects are similar to one another and consist of a hollow piercing organ, frequently barbed, and a sac containing an irritant fluid. When the "sting" enters the skin, poison from the sac is injected into the wound, with unpleasant results.

Diptera

Flies, of various species, are both annoying and dangerous pests of mankind; gnats and midges are capable of converting a pleasant hour in the country into a nightmare; house-flies and stable-flies may bring disease in their train.

The common house-fly, *Musca domestica*, L., is undoubtedly man's worst insect enemy in this country. We have dealt with the life-history of this insect in another portion of the book; here we are only concerned with its relationship to man. The belief that house-flies disseminate infectious diseases is not new. "Mercurialis (1577) considered that they carried the virus of plague from those ill or dead of plague to the food of the healthy. Sydenham (1666) remarked that if swarms of insects, especially house-flies, were abundant in summer, the succeeding autumn was unhealthy. A number of authors, *e.g.* Crawford (1808), might be cited who refer in a general way to insects, especially to house-flies, as carriers of infection. Moore (1853) refers to flies as possible carriers of cholera, typhoid, tuberculosis, anthrax, and leprosy. Leidy (1872) refers to flies as carriers of the infection of hospital gangrene and of wound infection, . . . but

none of these authors do more than offer surmises regarding the part played by flies in the spread of disease."

To avoid any misunderstanding as to the part played by house-flies in the transmission of disease, we may state at once that their work is purely mechanical, though none the less deadly on that account. Their mouths are not adapted for biting, and they are quite unable to pierce the human skin, or any skin for that matter, if they would. "They are a disgusting pest which feed and wallow in filth of all sorts, and when their proboscides and legs are covered with germs which are growing and living in such filth, they proceed to our food and to the food of our children and contaminate it. This infected food we human beings eat and drink, and in this way disease is kept circulating from one person to another in a never-ending cycle, the flies carrying disease from one sick person to the food of others, and perhaps to and from animals besides." In time of war the house-fly has proved more deadly than the enemies' bullets. During the Spanish-American war more than eighty per cent. of the deaths were due to typhoid; during the Boer war the number of deaths brought about by the agency of the house-fly is impossible to compute.

The disgusting habits of these insects have been mentioned elsewhere, how they swarm on all manner of filth and garbage and fly direct therefrom to our food and persons, which they soil with their excrement and vomit, in addition to carrying oddments of

the decaying matter over which they have walked and dropping it as they go. The deplorable number of deaths from typhoid that took place in the Spanish-American and Boer wars focussed the attention of entomologists on the house-fly. A Government report concerning the conditions of the former war states that: "It was impossible to keep the flies from the already cooked food, even if a man kept one hand over his plate and ate with the other"; whilst the American Army Medical Department, in a circular showing that flies were probably carriers of typhoid, states that: "They swarm about fæcal matter and filth of all kinds deposited on the ground or in shallow pits, and directly convey infectious material attached to their feet or contained in their excreta, to the food which is exposed."

During the war an Army Typhoid Commission was instituted, and its findings made it more and more clear that house-flies were responsible for the spread of typhoid. Dr Vaughan, who drew up a report for the Commission, laid especial stress on three points: that flies pass direct from fæcal matter to food, as was plainly shown when lime had been recently sprinkled over the contents of the pits, by the fact that insects, whitened with lime, were seen on the food; that the officers suffered less in proportion than the men—their mess tents were effectually screened; that with the approach of the cold weather and the consequent reduction in numbers of the flies, typhoid gradually decreased. The report continues: "It is possible for the fly to carry the typhoid bacillus in

two ways. In the first place, fæcal matter containing the typhoid germ may adhere to the fly and be mechanically transported. In the second place, it is possible that the typhoid bacillus may be carried in the digestive organs of the fly and be deposited with the excrement."

During the Boer war matters were no better. Tooth and Calverley, writing of typhoid during the war, state that, "in a tent full of men, all apparently ill, one may almost pick out the enteric cases by the masses of flies they attract. This was very noticeable at Modder River, for at that time there were in many tents men with severe sunstroke who resembled in some ways enteric (or typhoid) patients; and it was remarkable to see the insects hover round and settle on the enterics. The moment an enteric patient put his tongue out a fly would settle on it. . . . At Bloemfontein the flies were a perfect pest; they were everywhere, in and on every article of food. It is impossible not to regard them as important factors in the dissemination of enteric fever. Our opinion is further strengthened by the fact that enteric fever in South Africa practically ceases every year in the cold weather; and this was the case at Bloemfontein." So clearly did the evidence point to house-flies as carriers of typhoid during the war, that numerous investigators took up the matter and proved conclusively that they were very efficient vectors of the disease, even after a lapse of twenty-three days from the day of infection.

Another disease, with a higher death-rate than

typhoid, and, like typhoid, carried by house-flies, is infantile diarrhœa, or enteritis. "In London, during the year 1910, there died of this disease 1811 infants under two years of age; and during 1911, which had a hot summer, the infantile death-rate rose to even greater proportions. But in Bombay during 1910, 2263 died, and in Paris this disease killed 1152 infants; in New York, 5649; Chicago, 3384; Rio de Janeiro, 2692." As a final example we read that "during the hot weather at Cairo in 1909 it killed 3000 children in less than two months." At the Lister Institute in London Dr Morgan carried out a series of researches on this disease from 1905 to 1908, and succeeded in isolating a germ which he called Morgan 1. Rats fed on the bacillus died of enteritis; monkeys too, subjected to the same test, died exhibiting all the symptoms usual in children. The researches were continued, but attention was turned to house-flies, and in the bodies of many of these insects, taken from houses where there were children ill with infantile enteritis, the germs of the disease were found.

"But because infected flies were found after the onset of the cold weather in the autumn, and because some infected flies were found in a house in the country where no child suffering from the disease happened to be discovered, and because some doctors believed that the fly curves and the disease curves do not correspond, this research seems to have been relegated into the background. It should have been named as one of the most important investigations of

the present century. Flies may live for weeks in the cold weather—in fact, we know they do; but the majority die. And there may be enteritis-carriers, as we know there are typhoid carriers, who seem apparently healthy and who have had but mild attacks of the disease." So little notice, however, was taken of the established connection between house-flies and disease that in the summer of 1911 infantile enteritis broke out again nearly all over England; thousands of pounds were spent in a vain attempt to stem the tide of mortality; flies were everywhere, thriving in the decaying organic matter which the hot weather made plentiful, yet no one, apparently, gave any thought to a campaign for stamping them out and so mitigating the evil. In America, bacilli were discovered, similar to those discovered by Morgan, and equally pathogenic.

Various estimates have been made as to the number of bacteria that may be carried about the body of a single healthy, active fly; one investigator, Torry, puts the number at twenty-eight million in its intestine, and four and a half million on the outer surface. Esten and Mason, by careful experiment, found that the number of external bacteria varied from five hundred and fifty to over six and a half million; other observers have put the number as high as five hundred million per fly. The numbers seem incredible; that one house-fly can carry about its body as many as five hundred million germs is almost beyond belief, yet the estimated number is not the result of guesswork but of careful experiment. Look-

ing at the matter from the most favourable point of view, and supposing each fly to carry only five hundred and fifty bacteria from place to place, the supposition is not pleasant. A goodly number of these bacteria would assuredly be pathogenic, or disease-producing, and a fly laden with only fifty typhoid germs, and making an attempt on its life in a jug of milk, is an obvious source of danger, for these germs increase with surprising rapidity in such a favourable medium as milk. Speaking of the house-fly, or, as it is called in America, the typhoid fly, Howard says: "And as for the typhoid fly, that a creature born in indescribable filth and absolutely swarming with disease germs should practically be invited to multiply unchecked, even in great centres of population, is surely nothing less than criminal."

"The earliest experiments with anthrax in relation to flies are those of Raimbert (1869), who placed house-flies and meat-flies on infected material and afterwards tore off their appendages and inoculated them, with positive results, into animals. Experiments of a somewhat similar nature were made by Celli (1888), Sangree (1899), and Buchanan (1907), and they all agree in demonstrating that flies pick up anthrax bacilli when they walk about and feed on infected material. It remains to be determined how long flies may harbour the bacillus or its spores, and whether the virulence of the bacillus in the vegetative stage is modified by passage through the intestines of flies."

"The first to investigate the house-fly in relation

to the possible dissemination of the tubercle bacillus were Spillman and Haushalter (1887). These authors found tubercle bacilli in the intestinal contents and dejections of flies which had fed on tubercular sputum. Hofmann (1888) carried out observations under natural conditions by examining flies captured in the room of a phthisical patient. He found tubercle bacilli in four out of six flies examined, and also in the excreta of flies scraped from the walls, door, and furniture of the room. Velli (1888) has reported experiments by Alessi in which the latter fed flies upon tubercular sputum, and subsequently inoculated the flies' dejections into rabbits, thus causing the latter to become tuberculous." The cup is not yet full, for the ubiquitous house-fly has also been accused, and not without reason, though the proof is not yet forthcoming, of spreading diphtheria, dysentery, yaws, plague, tropical sore, small-pox, and swine-fever.

The house-fly problem is serious, but it is one which can be effectively grappled with, if the man in the street will make up his mind to do so.

The Stable-fly, *Stomoxys calcitrans*, L., is almost as widely spread as the house-fly. It closely resembles a stoutly built house-fly, is of a general grey colour, and, in the resting position, its wings are slightly spread. Its proboscis is an awl-like organ, totally unlike the soft proboscis of the house-fly; when at rest, it is carried horizontally and projects beyond the head, thus forming an easy means of distinction between the two flies.

The female deposits eggs to the number of about

sixty, on stable manure or decaying vegetable matter; they hatch in two or three days, and the legless larvæ are full-fed in about a fortnight. Both larvæ and pupæ closely resemble those of the house-fly. This insect attacks both man and man's cattle, easily piercing the skin with its formidable mouth parts. It has been shown to be a carrier of disease germs in more than one instance.

Several other Diptera are decidedly annoying to mankind. Species of *Simulium* are bloodthirsty and are also suspected of transmitting a disease known as pellagra. The gnats, or mosquitoes—the terms are synonymous, though, strangely, many people regard a mosquito as a far more formidable creature than a gnat—are often exceedingly troublesome. The females alone suck blood, the males content themselves with plant juices and the like. The common gnat, *Culex pipiens*, L., the spotted-winged gnat, *Theobaldinella annulata*, Meign., and *Anopheles* spp. are notorious. These insects were so fully dealt with in *Insects and Man* that we can only add here that Theobald, an acknowledged authority on *Culicidæ*, the family to which these insects belong, recommends the following mixture as a preventive of their attentions: pure carbolic acid, half an ounce; spirits of lavender, one and a half ounces; eucalyptus oil, one drachm.

Siphonaptera

The common flea, *Pulex irritans*, L., is an established household insect as well as a true parasite of man, although, unlike some parasites, it does not pass its

whole life-cycle on its host. It may be termed a temporary parasite. Fleas occur on practically all mammals and some birds. The species *irritans*, however, is the special parasite of man, though it also occurs on the badger. Some fleas are peculiar to certain hosts; others, again, do not confine themselves to one host; cat and dog fleas, for instance, are found on man. The Ungulates—oxen, sheep, and goats—are remarkably free from fleas and, incredible as it may seem, monkeys are quite free of these parasites, except those which they pick up from man himself.

The structure of the human flea is interesting. Its general outlines are, unfortunately, too well known to need description. A hard chitinous armour covers the whole insect; how resistant is this coat may be realised by nipping a flea 'twixt finger and thumb. This coat is more or less sparsely covered with backwardly pointing bristles, whilst below lies the insect's skin. In colour, the flea varies from pale straw to rich brown; in shape it is laterally flattened. This form of flattening is somewhat unusual, though highly advantageous to our subject. Dorsiventral flattening is common; the cockroach, as we have seen, and the bed-bug, as we shall see, are flattened in this manner—a fact which aids them in passing through narrow crevices. Fleas, for the most part, live on animals with hairy coats, and their peculiar shape aids their passage through hair. In finding their way from place to place on the body of their host, these insects appear to rely largely on their antennæ, and that these delicate organs may not receive injury, they fit into

grooves on either side of the head, when not in use. Many parasitic insects are provided with combs, horny protuberances from various parts of the body, which are of service in retaining their hold on the hirsute covering of their host. Fleas of many species are provided with these combs, though they are absent from *irritans*. To the non-scientist, perhaps the most striking feature of the flea is the enormous development of its hind legs, enabling it to jump prodigious distances; an active flea can jump a distance of nearly a foot, and nearly half that height.

The female flea deposits her eggs all the year round, unless a spell of exceptionally cold weather puts a temporary stop to domestic affairs. The eggs are laid in batches of one to five, and in a few days white, worm-like, legless larvæ emerge (fig. 49). Their emergence is not without interest. There is a thin, knife-edged plate on the head of each young larva; it is an egg-breaker. When ready to emerge, each larva within the egg works this plate against the shell till a crack is formed; further vigorous action makes a hole sufficiently large for the larva to escape. The larvæ obtain their nourishment from organic refuse of all kinds; in fact, they may be reared entirely on ordinary room sweepings. At the first moult the egg-breaking plate disappears, the insect having no further use for it. In a few days, at most, the larva is full-fed, when it proceeds to spin a cocoon, within which pupation takes place. A few days more—the duration depends on the temperature—and the adults appear. As is too well known, blood forms the food of mature fleas, though,

like all parasitic insects, they can survive for an extraordinary time without food.

The cat flea so commonly attacks human beings that a word or two concerning its habits may not be out of place. It may be distinguished from the human flea by the fact that it bears combs on its head and on the hind border of its pronotum. The adults spend practically all their time on their host; moreover, the female deposits her eggs thereon—the human flea never does so. The eggs are easily shaken from the cat's fur, and as the larvæ live on decaying organic matter, their next host, for a time at any rate, after attaining maturity, may be man himself.

It has been shown experimentally that the human flea is capable of transmitting plague; naturally, it probably never does so, for the reason that plague is transmitted from rats to man, not from man to man.

Fleas sometimes increase to an alarming extent in houses and, in such cases, they are difficult to eradicate. Liberal use of pyrethrum powder is the best and safest remedy. Fresh powder must be used or the results will be disappointing. Flaked naphthalene, freely scattered on the floors and left for a day or two, is also recommended. Cats and dogs should be examined for fleas and their eggs, and, if infested, the former should be well dusted with pyrethrum; the latter washed with Jeyes' dog soap. The bedding of both should be burned. Fleas about the person are usually only temporary worries. They show a distinct partiality for certain people, however, and in such cases the lotion advised for gnats may be tried.

Clothing may also be dusted with pyrethrum, but it is liable to cause irritation to sensitive skins. A remedy which has been well reported, consists in wearing two or three small bags of fine linen, filled with flowers of sulphur, affixed inside the clothing in the neighbourhood of either thigh and about the chest.

Rhynchota

For more than four hundred years the common bed-bug, *Cimex lectularius*, L., has been known in this country. It was apparently introduced into Britain about the year 1503, and was then known as the wall louse. Nowadays it is practically cosmopolitan, having followed in the wake of man throughout the world. This insect is popularly associated with unclean habitations, but its objective is blood and not dirt, so that it may be encountered from time to time in the cleanest dwelling. Like the flea, this insect is parasitic on man, though its parasitism is of a temporary nature. It feeds at night; by day, it hides in crevices, beneath paper, etc. It is almost as thin as the proverbial wafer, a circumstance which is advantageous in enabling it to creep into its hiding-places. Many parasites exhibit considerable degradation in structure, and the bed-bug is no exception.

As it seeks its food from the body of sleeping man, there is little need for active locomotion; as a consequence we find that the wings are represented by a pair of pads, useless for flight.

The adults measure about a quarter of an inch in

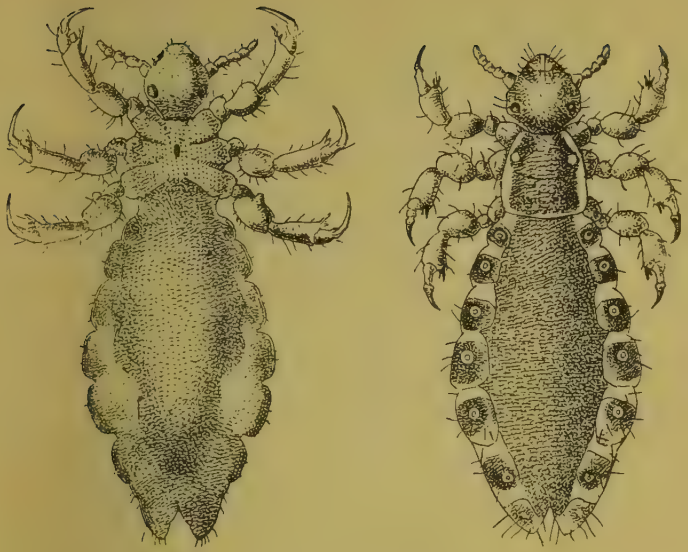


FIG. 50. HUMAN HEAD LOUSE. *Pediculus capitis*, DE G. FEMALE, DORSAL AND VENTRAL VIEWS

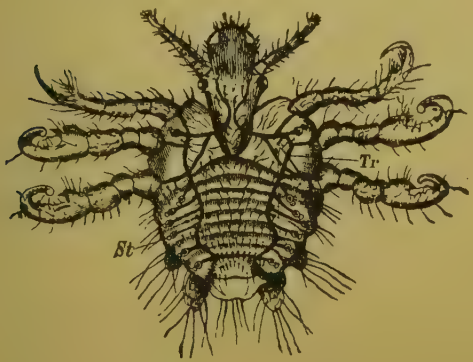


FIG. 51. CRAB-LOUSE, *Phthirius pubis*, L
St. SPIRACLES; *Tr.* TRACHEAE

length, and are obovate in outline and flattened dorsiventrally. In colour they are brownish red, with blackish markings on the abdomen. In the resting state, a formidable beak or rostrum lies against the lower surface of the insect's thorax. When about to feed, the rostrum is directed forwards; it is sharply pointed and easily capable of piercing the skin; through it blood is sucked.

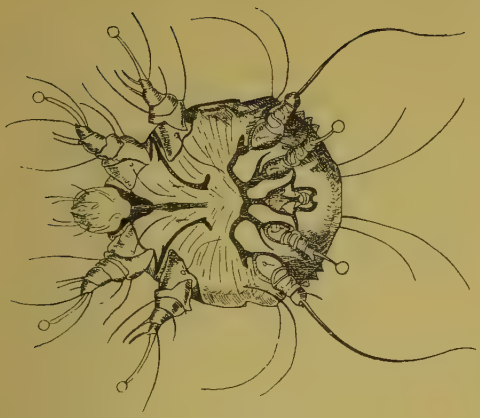
Like the flea, the bed-bug breeds continuously throughout the year, unless very cold weather intervenes. The insects are prolific. The females deposit their white, oval eggs in batches of from six to fifty, in various crevices out of harm's way. The eggs are covered with a sticky secretion, by means of which they adhere to the surface on which they are deposited. Each egg has a lid, or operculum, at its free end which is pushed up by the young bug when it emerges after a week or ten days. Metamorphosis is incomplete, and the young bugs resemble their parents in many ways. They are quite white, however, and nearly transparent. In a few hours they become straw-coloured and, after their first meal of blood, their abdomens, except for the extreme tip, become red. After five moults the adult stage is attained. Before each moult a full meal of blood is taken, so that in the seven to eleven weeks during which the young bug is attaining its full development five meals are taken. Low temperature and a lack of food may retard development considerably, but the number of meals remains the same. Before oviposition, also, the female has a full meal; in fact, it

is an almost invariable rule, among insects of similar habit, that the females are incapable of laying fertile eggs till they have partaken of a meal of blood. The bed-bug also conforms to another rule among blood-parasites—it can survive for very long periods without partaking of food. The bed-bug has been shown experimentally to be a transmitter of diseases, typhoid and relapsing fever among others; that it transmits disease naturally is highly probable.

Pouring benzine, or boiling water, over the hiding-places of the insects will destroy large numbers. Fumigation with sulphur is effective, and the use of hydrocyanic acid gas still more so. Cockroaches and red ants prey upon bed-bugs.

Pediculæ

Lice are even more disgusting pests of man than bed-bugs; they are truly parasitic and spend their whole time upon their host. Their courtship, egg-laying, and immature stages are all passed upon the body which provides their food. In ordinary times, and with the usual amount of cleanliness which rules among civilised communities, these little pests are not, as a rule, too much in evidence. Where large numbers of men are crowded together, without proper hygienic facilities, lice increase to alarming proportions. The true lice are confined to mammals; they are wingless, their feet are adapted for holding and clasping hairs, and their mouth parts consist of tubular, suctorial organs, provided with an armature of lancets. When not in use, these mouth parts can be



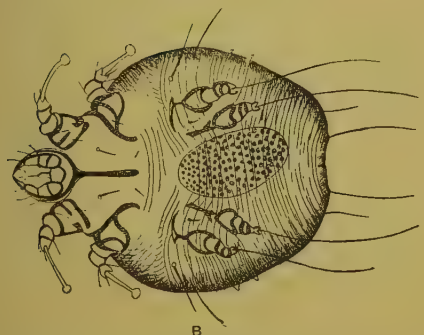


FIG. 52. HUMAN ITCH MITES, *Sarcoptes scabei*, DE G.
a. MALE ; *b*. FEMALE

completely withdrawn into the head, by being rolled inside out like a glove finger.

There are three species of lice common to man, the head louse, *Pediculus capitis*, de G. (fig. 50), the body louse, *Pediculus* (*vestimenti*) *corporis*, de G., and the crab louse, *Phthirius* (*inguinalis*) *pubis*, L. (fig. 51). Although only fifty years ago these insects were the constant companions of even the upper classes in England, they are now coincident with insanitary conditions.

The head and body louse closely resemble one another, so closely, in fact, that many people still look upon the latter as a variety of the former. The head louse never leaves its host of its own volition; the body louse hides in clothing and seeks its host when hungry.

The head louse is usually confined to the hair of the head, upon which the female deposits, singly, her small, white, pear-shaped eggs or "nits." In about a week the larvæ appear, and closely resemble their parents. Maturity is attained, after several moults, in about a month. The adult females are about an eighth of an inch long, and the last abdominal segment is forked. In the male, which is smaller, this segment is rounded.

The body louse is even more prolific than its relative; it has been estimated that a single female may produce eight thousand young in eight weeks. This fecundity has become a byword, for it has been said that a body louse may become a grandfather in twenty-four hours. The eggs are deposited in

clothing; whilst larvæ and adults feed upon various parts of the body. This insect is very strongly suspected of transmitting typhus fever.

The crab louse somewhat resembles a small crab in outline. It measures from one-twentieth to one-tenth of an inch in length, and normally inhabits the pubic regions, though it may travel to the armpits, eyebrows, and even beard. Its enormously developed claws are not fitted for clasping the fine hairs of the head, so it never appears in that region. In colour the adults are white, with a dark patch on either shoulder and reddish legs and claws. It is even more prolific than the other human lice. The pear-shaped eggs are attached to hairs, the larvæ emerge in about a week, a fortnight later the adult stage is reached.

The frequent use of soap and water is the best preventive of these vermin. Treating the hair with paraffin will kill the hair louse, but several applications are necessary, as the eggs are not destroyed by this treatment. In cases of infestation by the body louse, the clothes should be thoroughly steamed. The crab louse may be eradicated by the persistent use of mercurial ointment.

Mites

The itch mite, *Sarcoptes scabei*, de G. (fig. 52), is a troublesome human parasite. The insects are white, about a sixteenth of an inch in length, flattened and circular in outline. They pass through all their stages on the host, and their attacks on man are

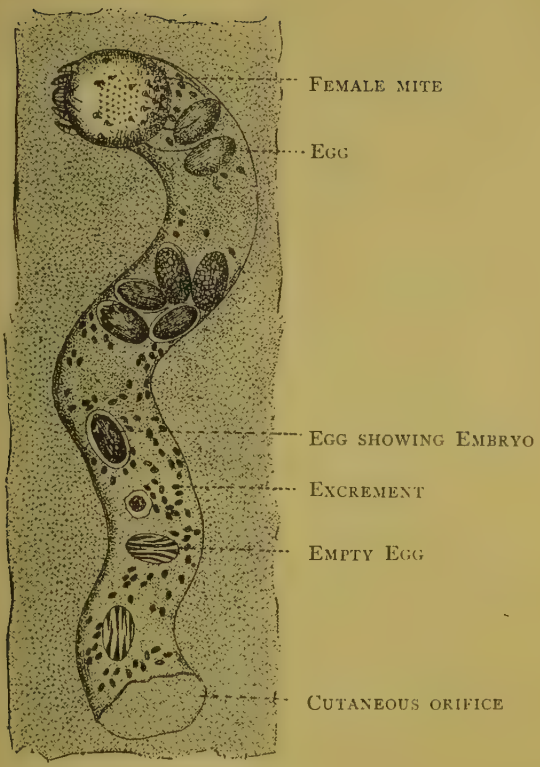


Fig. 53. Burrow of Itch mite in human skin.

characterised by intense irritation, usually at the base of the fingers and between the knuckles. The mites burrow into the skin, and the females deposit their eggs as they travel deeper and deeper (fig. 53). The young feed on the surrounding tissues of the burrow, till, after four moults, they come to the surface of the skin and mate; later, the young females make fresh burrows in the skin.

A good remedy is the liberal and persistent application of sulphur ointment, following a thorough soaking of the afflicted parts in hot water.

Many more of man's insect enemies could be mentioned, some important, others of mere academic interest, but space, or lack of it, forbids a more exhaustive survey. In conclusion, let us urge our readers to beware of the blood-sucking insect. Not many years ago, the origin of several dread diseases was a mystery to the physicians of the time; to-day they are known to be insect-borne. The blood-sucking insect may be merely an annoyance or he may carry disease. With these pests, reverse the British idea of justice, and consider them guilty till their innocence is proven.

APPENDIX

METHODS OF USING VARIOUS INSECTICIDES, ETC.

FUMIGATION.—In all cases the rooms or vessels to be fumigated should be made as air-tight as possible.

SULPHUR, when burned in air, produces a pungent gas known as sulphur dioxide. It is a useful fumigant but has bleaching properties, so that it is injurious to fabrics. It also forms compounds with various metals, tarnishing them badly. Two pounds of sulphur should be burned for every thousand cubic feet of space to be fumigated.

CARBON BISULPHIDE, is a somewhat oily liquid which evaporates rapidly in the air. It has a most unpleasant odour when impure. *This substance is poisonous and its vapour is highly inflammable.* Two pounds of the liquid should be used for every thousand feet of space. It should be poured into shallow vessels to facilitate evaporation. After use, on the admission of air, the odour rapidly vanishes.

HYDROCYANIC ACID GAS, *is so poisonous that it should never be used by the amateur.* It is made by the action of sulphuric acid on potassium cyanide. The salt should be pure and used in the proportion of ten ounces for every thousand feet of space.

Other substances used to combat household insects are:—

TOBACCO, may be used either as a fumigant or as a spray. For the latter purpose, either three pounds of tobacco powder or half a pound of tobacco leaf should be infused in water for at least six hours; the infusion

should then be made up to ten gallons with water in which half a pound of soft soap has been dissolved.

Naphthalene, gives off a powerful irritating vapour when fresh. It may be freely scattered about rooms, and can be swept up when it has served its purpose without causing damage to fabrics, etc.

Benzine, is a highly volatile and *very inflammable* liquid. In the pure state it leaves no stain on, nor does it cause damage to, fabrics.

Pyrethrum, is a powder obtained by grinding up the flowers of certain *Compositæ*. It should always be used fresh, in which state it is highly effective, in many cases, but it rapidly loses its strength.

Formalin, is a liquid. It consists of a solution (usually 40 per cent.) of formaldehyde, in water. It has an irritating, somewhat penetrating odour.

Tanglefoot, for grease-bands. Ready-prepared mixtures may be obtained, or, in an emergency, ordinary cart-grease may be used.

Caustic Alkali Wash.—The simplest wash of this nature consists of two pounds of caustic soda, dissolved in ten gallons of water.

Arsenical Sprays.—*All mixtures containing Arsenic are exceedingly poisonous.* Arsenate of lead may be bought ready for use in the form of Swift's arsenate of lead paste. It may also be compounded of arsenate of soda two ounces, acetate of lead seven ounces, and water ten gallons.

Paris Green Wash, is compounded of one ounce of Paris green to ten gallons of water. The mixture should be stirred constantly, to keep the Paris green in suspension.

Quassia Wash.—Dissolve half a pound of soft soap in water, boil a pound of quassia chips in water for at least two hours and strain. Mix the two solutions and make up to ten gallons with water.

Zinc-Lead Mixture.—Take seven pounds of linseed oil, two and a half pounds of white lead, and one pound of zinc oxide; boil for ten minutes, allow to cool, and add one pound of turpentine.

Carbolic Acid Wash, is made up of one pint of carbolic acid, half a pound of soft soap, and ten gallons of water.

Glue and Bran.—Dissolve two pounds of glue in one gallon of water, add half a pound of bran to the mixture.

Carbolic Acid and Lime.—Add the acid to the lime till the mixture is of the consistency of thin cream.

Paraffin-Sand Mixture.—Use half a pint of paraffin to a bucketful of sand.

Paraffin-Ammonia.—Paraffin one gallon, soft soap half a pound, water ten gallons; mix thoroughly, then add four ounces of ammonia.

Paraffin Jelly.—Boil together eight pounds of soft soap, five gallons of paraffin, and one pint of water. The mixture will form a jelly on cooling. For use, take a pound of the jelly and mix with three gallons of water.

Paraffin Emulsion.—Dissolve half a pound of hard soap in a gallon of water, boil, and when just off the boil add two gallons of paraffin, stir well, then emulsify by means of a syringe or similar apparatus. The mixture should be diluted with ten parts of water for use.

BIBLIOGRAPHY

GENERAL

1860. Curtis, *Farm Insects.*
1890. Ormerod, *Manual of Injurious Insects.*
1895. Miall, *Natural History of Aquatic Insects.*
1895. Railliet, *Traité de zoologie médicale et agricole.*
1895. Sedgwick, Sinclair, and Sharp, "Peripatus, Myriapods, and Insects," *Camb. Nat. Hist.*, vol. i.
1896. Butler, *Our Household Insects.*
1896. Osborn, *Insects affecting Domestic Animals*, U.S. Dept. of Agriculture, Bureau of Entomology, Bulletin 5.
1899. Sharp, "Insects," *Camb. Nat. Hist.*, vol. ii.
1901. De Champville, *Les ennemis du blé.*
1901. Howard, *Insect Book.*
1902. Osborn, *Poisonous Insects.*
1908. Gillanders, *Forest Entomology.*
1908. Howard, *How Insects affect Health in Rural Districts*, U.S. Dept. of Agriculture, Farmers' Bulletin 155.
1909. Theobald, *Insect Pests of Fruit.*
1910. Doane, *Insects and Disease.*
1911. Alcock, *Entomology for Medical Officers.*
1912. Collinge, *Manual of Injurious Insects.*
1912. Sanderson, *Insect Pests of Farm, Garden, and Orchard.*
1912. Truffaut, *Les ennemis des plantes cultivées.*
1913. Patton and Cragg, *A Textbook of Medical Entomology.*
1913–1916. *Review of Applied Entomology*, London, Series A and B.
1914. Herrick, *Insects injurious to the Household.*
1915. Ealand, *Insects and Man.*

LEPIDOPTERA

1895. Meyrick, *Handbook of British Lepidoptera.*
1908. Marlatt, *The True Clothes Moths*, U.S. Dept. of Agriculture, Bureau of Entomology, Circular 36.
1911. Britton, "The Leopard Moth as a Pest of Apple Nursery Stock," *Journal of Economic Entomology*, vol. iv. p. 298.
1912. Girault, *The Angoumois Grain Moth.*

COLEOPTERA

1867. Smith, "Note on *Anobium tessellatum*," *Ent. Monthly Mag.*, vol. iii. p. 279.
1891. Fowler, *British Coleoptera.*
1910. Hertzog, "Notes on the Cigarette Beetle," *Journal of Economic Entomology*, vol. iii. p. 198.

DIPTERA

1901. Howard, *Mosquitoes: How they Live.*
1905. Collinge, *Life-history of the Pear Midge.*
1905. Collinge, "On the Deposition of Eggs and Larvæ of *Œstrus ovis*," *Journal of Economic Biology*, vol. i. p. 72.
1906. Howard, *House Flies*, U.S. Dept. of Agriculture, Circular 7.
1906. Newstead, "On the Life-history of *Stomoxys calcitrans*," *Journal of Economic Biology*, vol. i. p. 157.
1906. Washburn, *Cabbage Root Fly*, Minnesota Univ. Agric. Expt. Stat., Bulletin 100.
1909. Boyce, *Mosquito or Man.*
1909. Felt, "The Economic Status of the House-fly," *Journal of Economic Entomology*, vol. ii. pp. 39–45.
1912. Hewitt, *House Flies.*
1913. Bishopp, "The Stable Fly, an Important Live-stock Pest," *Journal of Economic Entomology*, vol. vi. p. 112.
1914. Carpenter and Hewitt, "Some New Observations on the Life-history of the Warble Fly," *Irish Naturalist*, October.

HYMENOPTERA

1889. Riley, "The Little Red Ant," *Insect Life*, vol. ii. pp. 106–108.
1893. Cameron, *Monograph of British Phytophagus Hymenoptera.*
1903. Morice, "Help Notes for the Determination of British *Tenthredinidæ*," *Ent. Monthly Mag.*, January.
1910. Wheeler, *Ants, their Structure, Development, and Behaviour.*

RHYNCHOTA

1876. Buckton, *Monograph of British Aphides.*
1900. Newstead, *Monograph of British Coccidæ.*
1907. Marlatt, *Bed-bugs*, U.S. Dept. of Agriculture, Bureau of Entomology, Circular 47.

1912. Patch, "Woolly Aphis Migration," *Journal of Economic Entomology*, vol. v. pp. 395–398.
1914. Girault, "Researches on the Bed Bug," *Journal of Economic Entomology*, vol. ix. pp. 25–45.
1915. Baker, "On the Early History of the Woolly Apple Aphis," *Journal of Economic Biology*, vol. x. No. 3.

ORTHOPTERA

1886. Miall and Denny, *The Cockroach.*
1896. Seiss, "On the Breeding Habits of *Periplaneta orientalis*," *Ent. News*, vol. vii. pp. 148–150.
1906. Washburn, "Cockroaches," *Eleventh Annual Report of the State Entomologist of Minnesota.*

SIPHONAPTERA

1909. Howard, *House Fleas*, U.S. Dept. of Agriculture, Bureau of Entomology, Circular 108.
1911. Sambon, "The Rat Plague in East Anglia," *The Times*, January 30 and February 4.
1913. Russell, *The Flea.*

MITES

1909. Herrick, "Notes on Mites affecting Chickens," *Journal of Economic Entomology*, vol. ii. p. 341.
1915. Banks, *The Acarina or Mites*, U.S. Dept. of Agriculture, Report 108.

REMEDIES, ETC.

1902. Hinds, *Carbon Bisulphide as an Insecticide*, U.S. Dept. of Agriculture, Farmers' Bulletin 145.
1904. Surface, "Remedies for Cockroaches," *Annual Rept. Penn. State Dept. of Agriculture.*
1906. Marlatt, *Sulphur Dioxide as an Insecticide*, U.S. Dept. of Agriculture, Bureau of Entomology, Bulletin 60.
1907. Howard, "Two New Remedies for Fleas," *Science*, vol. xxvi., November 29.
1909. Skinner, "A Remedy for House Fleas," *Journal of Economic Entomology*, vol. ii. p. 192.
1912. Howard and Popenoe, *Hydrocyanic Acid Gas against Household Insects*, U.S. Dept. of Agriculture, Bureau of Entomology, Circular 163.

INDEX